VOLUME VIII #3 MARCH 1993 PRICE $6

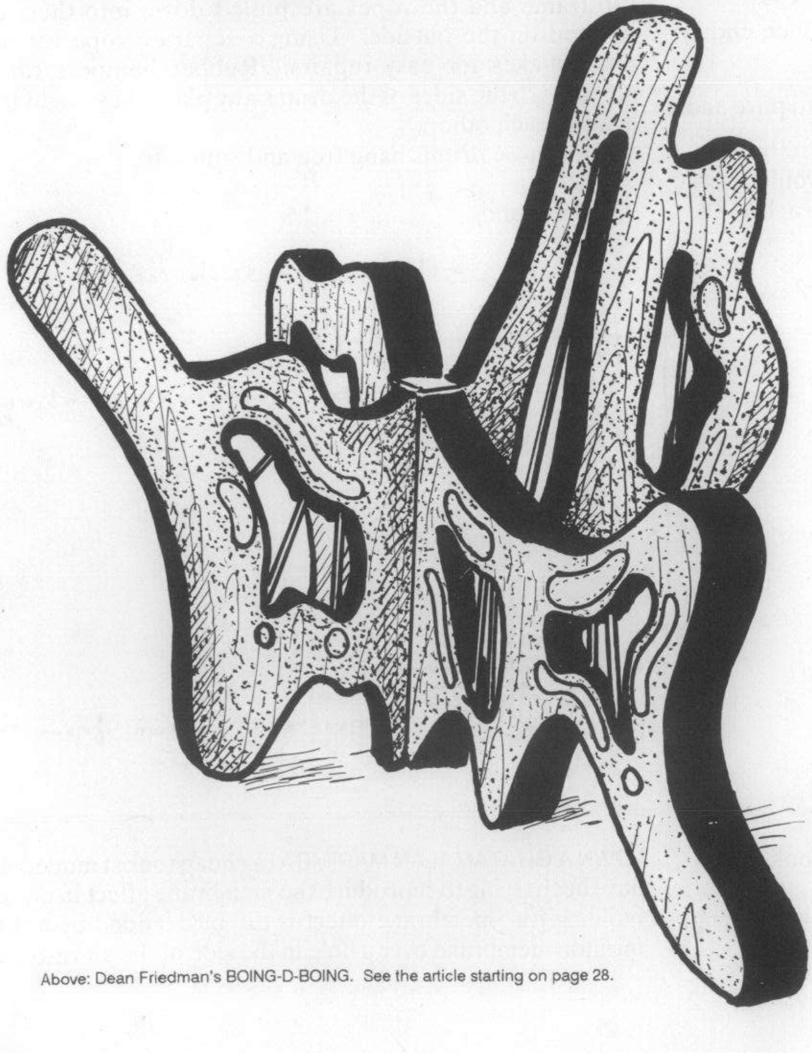
FOR THE DESIGN, CONSTRUCTION AND ENJOYMENT OF UNUSUAL SOUND SOURCES

EXPERIMENTAL MUSICAL INSTRUMENTS

WHAT NOW?

For some time, EMI has been promising to have a report on *theremin*, the early electronic instrument played by moving one's hands about in space before the instrument, without touching. That promise is fulfilled in this issue. Included are a longer article describing the operating principles, the history, and the cultural context of the instrument, plus a shorter piece with instructions for making a simple theremin. EMI has also been promising an article on theory and practice for wind instrument toneholes, and you will find that here too. The article deals primarily with tonehole sizing and placement, while a follow-up in the coming issue will cover the practical side of tonehole making.

IN THIS ISSUE



Above: Dean Friedman's BOING-D-BOING. See the article starting on page 28.

Also in this issue you will find a pictorial report on Ken Butler's *Hybrid Instruments*, which use functional non-musical objects as the bodies for strange/familiar string instrument forms. Reed Ghazala continues his series on *circuit bending*, the deliberate, if unpredictable, alteration of inexpensive electronic components in search of new sounds. Wesley Brown describes the design and construction of a slide bass clarinet. The Boing-D-Boing, seen in the drawing on this page, is one of several instruments Dean Friedman describes in his article on the *Music Atrium*, a hands-on museum installation for children. Plus we have the usual mix of reviews, letters, notices and such. AND SO ... we're off.

From the editor: Alan Tower, author of the letter that follows, called me in October, asking if I could suggest an acoustic sound source that would create an effect somehow reminiscent of butterflies. It happened at the time that I had been reviewing some of the writings of sound sculptor Dan Senn. He had described something he calls **flutter moths**, in which washers are allowed to slowly spin their way down along threaded rods, making a sound as they go. I had never heard the sound, but the name sounded right, so I suggested the idea to Alan. Sometime later I received the following letter.

THANK YOU AGAIN for your help in identifying a butterfly sound for a recent performance in San Francisco I was involved in called, Wings for the Earth. The evening was a benefit for a group of folks who ranch rainforest butterflies, selling direct to museums and collectors thereby providing work for indigenous peoples and protecting those types of butterflies in the rainforest. The modern dancer and poet I was working with wanted a live sound appropriate for the piece. Your suggestion of using a threaded rod with washers cascading down worked perfectly. The things I discovered in the process were:

1. The size of the washer determines the type of sound.

2. Washers are all slightly different - some are faster, some slower, some get stuck, and some slip down the rod very chaotically. Many washers must be tried to find the ones that work best.

3. The effect depends on which side of the washer is placed face down on the rod, as the inner edge is slightly different for different washers.

4. The rod will work differently depending on which end is used up top.

5. Damping the rod with the hands keeps the sound pure and less metallic.

I tried using the rod and washers like one would use a rainstick, flipping it over as the first washers reached the bottom. However, the washers would not catch quickly enough in their downward spiral for my taste. Too much metallic noise was created before they began spinning in their unique way. On a five-foot rod the washers took around two minutes to descend. Just before they are about to fall onto a towel I put a couple more on up top, beginning another descent. A washer scraped vertically along the rod at the same time also seems to add an interesting sound appropriate to the forest.

I used two mikes, one at two feet and one at five feet, in order to pick up the sound, and had the gain up pretty high. The sound filled the hall and was very close to that of fluttering butterflies and insects. The visual effect is also interesting as each washer looks much like the beating wings of a moth.

It was a hit. Thanks again. If anyone is interested in pursuing this idea further they might contact Dan Senn. Dan has been experimenting with the creation of instruments based on this principle for years. He makes very elaborate sculptures and also uses wooden washers and piezo disks for picking up the sound.

Alan Tower

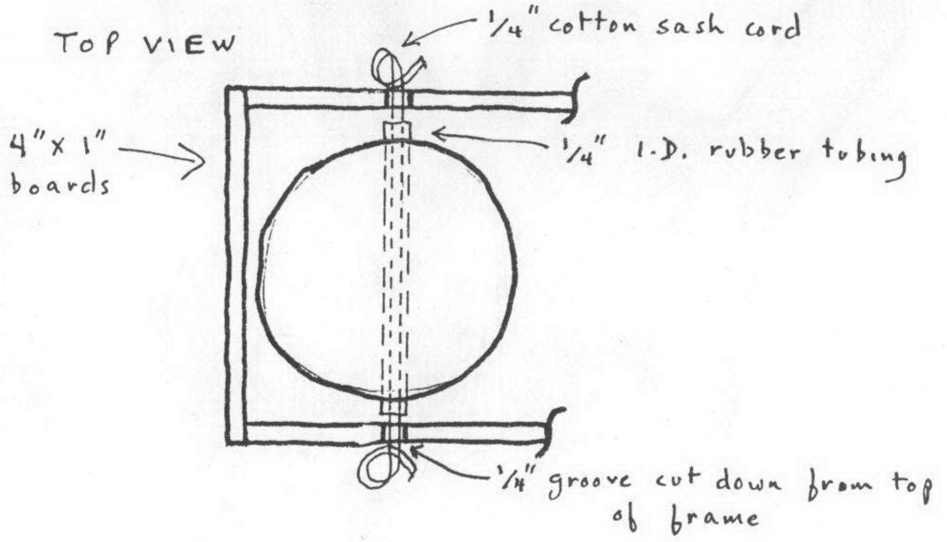
Dan Senn can be reached through Newsense Intermedium at 1933 Commerce #3 Takoma, WA 98402; phone (206)272-3241; fax (206)272-3285. Newsense Intermedium will soon be releasing (or may have released already, by the time you read this) a recording called "Flutter Moths", available in cassette and DAT for $12, featuring in large part the Flutter Harp sound sculpture.

I REALLY ENJOYED "Kitchen Drums" by Luc Reid -- truly minimal percussion. His drums and most others would give a more resonant sound if they were suspended loosely, not bolted firmly to their stand. To do this: a few inches below the top, drill 1/2" holes on either side and suspend the drum on 1/4" cotton sashcord inserted inside 1/4" (I.D.) rubber surgical tubing [see the drawing below]. The drums are then hung in a top frame which is a rectangle, as shown in the diagram, a bit wider than the drums, or a double rectangle for two rows of drums. The surgical tubing is as long as the inside width of the frame, and the rope 6" longer.

Grooves 1/4" wide are cut down an inch or so into the top frame and the ropes are pulled down into them and knotted on the outside. Using a separate rope for each drum makes for easy repairs. Rubber bumpers can be glued on to the sides of the drums any place they might bang against each other.

Let those drums hang free and sound free!

Peter Denny



I OWN A GUATAMALAN MARIMBA (a cheap tourist model) and have been trying to reproduce the membrane effect in my own building [the membrane effect is the buzz added by a small mirliton membrane over a hole in the side of the air resonator

below the bar, used in some African and Central American marimbas]. In the August '89 issue of EMI, Blake Mitchell sent in an excerpt from **The Book of the Marimba**, which has helped my experimentation. The best results I've achieved are with a saran wrap membrane, but the cheap little tourist model still sounds better than mine. Goldbeater's skin was mentioned as a possible material for membranes, and I'd like to try it though I can't find a source. The local gold leaf shops can't help me and I thought that maybe someone out there could.

Also, I've been pursuing **The Book of the Marimba** by Frank McCallum. Does anyone have a copy that they'd like to sell, trade or xerox? Or know where I could find one? The person who sent the article in (Blake Mitchell) reportedly was working on his own book **Wake the Marimba**. My local bookstores don't have this in their computers. Was it ever published?

Most of my first couple of years of building was experimenting and discovering things which I've come to find out is already in books and it would be probably advantageous and time saving to me to benefit from what other people have already figured out!

Pete Hurney
376 Hamilton St.,
Costa Mesa, CA 92627

From the editor: Blake Mitchell's **Wake the Marimba** is still in preparation (good things take time). Anyone with leads on the Frank McCallum book, please contact Peter Hurney at the above address. Meanwhile, since writing the above letter, Peter has had some luck with goldbeaters skin. In a second letter he writes:

I did find a gold leaf maker in New Jersey who was willing to part with a small 4"x4" piece of goldbeaters skin and that'll be good to experiment with. Most of the gold leaf I've discovered is made in Germany these days. I'm not sure about getting some animal guts and making the stuff myself – that's a little out of my line, but maybe some other people have some good ideas of other materials to use. Saran wrap is still the best I've discovered so far.

Here's an idea that might titillate your readers. How about making a call for submissions on dream instruments (i.e. instruments that are invented while dreaming). Here is my submission. I dreamed about an open hole, transverse flute that is made of a bendable material. I speculate that, with such a flute, you could change in intonation "on the fly".

Glenn Engstrand

THIS A SHORT LETTER to respond to Mike Hovancsek's generally positive but otherwise almost wholly inaccurate and ill informed review of a tape "Jacksonian March", which I edited, and which was reviewed in EMI Vol. 8 #2.

The tape is NOT, as was stated, available from WiDEMOuth Tapes! [See the note below – ed.] It is available from the Isolation Chamber Music Society, PO Box 22142, Balto, MD 21203. There is a small dedication to wiDEMOuth tapes in the accompanying material, but the relation is made explicit. The tape is not "...a series of piece by tENTATIVELY, a cONVEINIENCE & others" – it is a collection of recordings by 22 individuals that happened to be doing a certain kind of conceptually driven work in Baltimore at the time, including tENT & myself.

Mike says "Surprisingly, these pieces are process pieces (sic), where in the past these people have worked in a live, primarily improvised format." I can't imagine how Mike would feel qualified to make such a statement – or how he could be familiar with my 12 years of Audio output or, for that matter tENT's or anyone else on the tape (who he doesn't mention) output. In fact, he happens to be completely wrong in the obvious sense that most of our activities don't center around improv, and that some of the pieces on the tape happen to be improvisation! In fact, the majority of output of myself, tENT & others on the tape is either "Composed" or some other less mainstream category, and a small fraction involves live improv.

Mike also says liner notes are non-existent. [Again, see the note below – ed.] Here he must be referring to the 2 pieces of printed matter which accompany the tapes, including explicit reference material for nine of the pieces as well as several overall contextual texts. Mike never really mentions the peculiarities of the tape expressed there: The use of unusual sound-sources and attitudes towards recording such a Neil Feather's instruments, or the cab of a giant truck, or a dog whistle, or a barking dog, or a complex feedback system; and the important fact that the tapes is contextualized as not music but instead investigation into peripheral perceptual states, such as those engendered by epilepsy, which the title "Jacksonian March" medically refers to. Like most of our activity, it is self-consciously & elaborately opposed to cliche categorizations and hence, despite his apparently liking it,

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SUBMISSIONS: Experimental Musical Instruments welcomes submissions of articles relating to new or unusual musical instruments. A query letter or phone call is suggested before sending articles.

almost wholly unreviewable by someone as apparently steeped in that as Mike.

A bad review from a great magazine.

John Berndt

From the editor: The blame for the incorrect note on who published **Jacksonian March** and where it is available should go to myself, the editor, and not the reviewer. It was me who supplied that (mis)information. It also appears likely that the liner notes that John Berndt refers to in his letter got separated from the tape in the somewhere in the shuffle in this office, and never reached the reviewer. That would explain many of the problems that John's letter criticizes. That too is my responsibility. Apologies to John Berndt and reviewer Mike Hovancsek for these errors.

UNFORTUNATELY, reviewer Mike Hovancsek has made a couple of errors in his review of the *ECHO: Images of Sound II* CD on page 37 of EMI Vol. VIII #2 Dec '92.

Takehisa Kosugi's piece on the CD is made with a table covered with little electronic objects, effects pedals and contact microphones. It is a performance also using voice, violin, flute and lamella. The radio transmitter mentioned was exhibited but is not on the CD.

Joe Jones' piece on the CD *is* called "Small Orchestra and features small solar powered toy instruments mounted on music stands which Jones "plays" by inserting pieces of blotting paper between the solar panels and the lights aimed at them. The baby carriage Mike Hovancsek mentions is a work entitled "Putting the Baby to Sleep" and is also a vehicle for solar powered machine instruments. The vibrations of the carriage's movement have nothing to do with it.

All this is very clearly written about and illustrated with photographs in the 36-page booklet with the CD. There are texts and photographs of both works by both composers. I'm not sure how things got confused or (in the case of Jones' work) misinterpreted.

Aside from this little attempt to put things right, I'm also wishing all the best for the coming year. Hopefully we can all have a smooth, happy, creative time.

Ernie Althoff

NOTES FROM HERE AND THERE

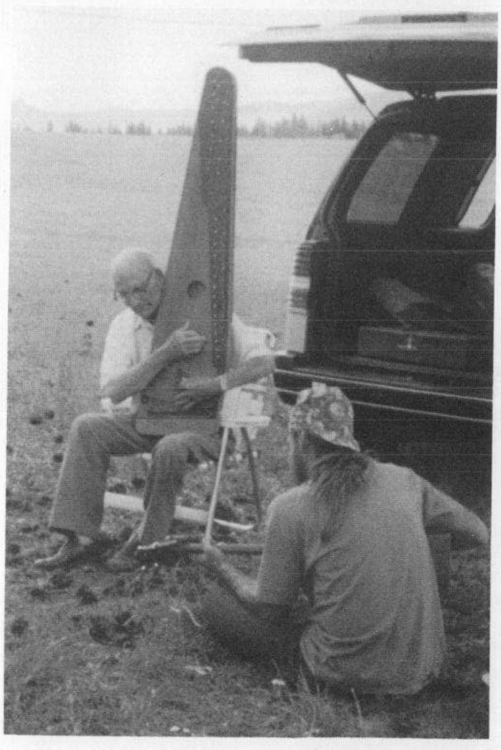
THE TUNING OF THE WORLD, the First International Conference on Acoustic Ecology, will take place August 8 - 14, 1993 at the Banff Centre for the Arts in Alberta. The conference is an interdisciplinary exploration of the relationship between sound and the environment. It will bring together artists, scientists, scholars, environmentalists and educators committed to finding ways of "tuning" our acoustic environment. Scheduled speakers include R. Murray Schafer, Ursula Franklin, Mickey Hart, Pauline Oliveros, Klaus Schoening and many more. For information write to Conference Registrar, The Tuning of the World, Banff Centre for the Arts, Box 1020, Stn. 28, 107 Tunnel Mountain Drive, Banff, Alberta, Canada, T0L 0C0; phone (403) 220-3493.

PURVES PULLEN, better known as Horatio Q. Birdbath of the Spike Jones band, died this last fall at age 83, leaving just two of the original band members still alive: drummer Joe Siracusa, and Earl Bennett, a.k.a. Sir Frederick Gas.

GORDON FRAZIER, WHO WAS THE MAIN FORCE behind last summer's Sumpter Valley Jew's Harp Festival, has sent along the photos shown here from the festival. Left: Leo Tadagawa (editor of the Japanese journal **Koukin**) with a cardboard stage-prop harp, while Waylan Harman plays a hand-carved alder harp of his own design. Right: among a number of other sorts of instrumentalists present was Homer Welty, playing one of his long-scale autoharps (notable for a number of innovative design features – EMI hopes to report on Mr. Welty's work in these pages one of these days). Sitting in the foreground at right is Waylan Harman.

The Sumpter Valley Festival has given rise to **Pluck**, a triannual newsletter devoted to the instrument, available for

Photos below: Scenes from the Sumpter Valley Jew's Harp Festival



$10/year from Gordon Frazier, PO Box 14466, Seattle, WA 98114. A second annual Sumpter Valley Jew's Harp Festival is planned for July 30 - August 1, 1993. There are also tentative plans for a Third International Trump Congress (*trump* being another term increasingly used as a generic for the same family of instruments) to be held in Kyrgystan (central Asia, north of Afghanistan), also in the summer of 1993. For information on either or both, contact Gordon Frazier at the above address.

BRIEF MENTION — Several books of potential interest to EMI readers have recently been published:

The Oxford Companion to Musical Instruments, by Anthony Baines, is a major new resource in the field, at over 400 pages. Available from Oxford University Press, £25.00.

The Conservation and Technology of Musical Instruments, by Cary Carp, is a collection of 955 abstracts of articles from a wide range of published sources relating to musical instrument technology. Available for $40 from Getty Conservation Institute, 4503 Glencoe Ave., Marina Del Rey, CA 90292.

A Trumpet by Any Other Name: A History of the Trumpet Marine by Cecil Adkins and Alis Dickinson is 2-volume work (612 pages total) comprising a history of this most peculiar of

(continued next page)

FROM THE 3rd ANNUAL CHICAGO INVENTED INSTRUMENTS FESTIVAL: The photo below shows Bill Wallace, Bill Close, and Patrick Otteson (from the ensemble *Redfish*) performing on stainless steel drums built by Bill Wallace as part of the 3rd annual Chicago Invented Instruments Festival at the HotHouse on October 31, 1992. Other drums by Bill Wallace and Bill Close's long-string instrument can be seen in the background.

In addition to Redfish, the 1992 festival included solo electro-acoustic sound palette improvisations by Hal Rammel, the string and wind instruments of Julie Smith, and the large string sculptures of Bill Close.

As has become traditional with the festival, the evening opened with a performance by the Experimental Sound Studio Big Band. This ad hoc ensemble features the work of participants in the Experimental Sound Studio-sponsored "Instrument Invention and Sound Exploration" workshop that has preceded each festival over the past three years. Led by Hal Rammel, the workshop is offered to anyone interested in designing, building and playing unique acoustic sound sources using recycled and found materials and simple building techniques. This year's workshop included presentations by visiting artists Douglas Ewart and Don Meckley. The 1992 edition of the ESS Big Band included Eric Leonardson, Greg O'Drobinak, Steve Rom, Julie Smith, and Karen Westling improvising on their newly built instruments.

The 1993 Invented Instruments Festival and "Instrument Invention and Sound Exploration" workshop is scheduled for April (Saturdays, April 3, 10, 17 and 24, with the concert on the 24th). For further information contact the Experimental Sound Studio in Chicago at (312) 784-0449.

early European string instruments and a catalog of surviving specimens.

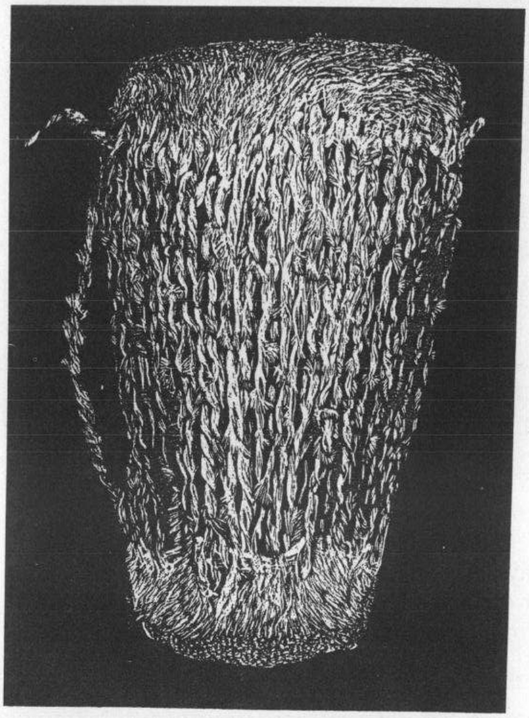
Directory of Historical-Instrument Makers in North America is a 22-page directory compiled by the people at Early Music America, and available for $4.95 from them at 30 West 26th St., Suite 1001, New York, NY 10010.

Greg Curnoe was killed in a bicycle accident on November 14th, 1992. Greg was the founder of the Nihilist Spasm Band, the extraordinary group of noise performance people centered in London, Ontario [featured in EMI Volume II #1]. The band used home-built or found instruments, as well as declamatory vocals, to create a raucous, urgent sort of music. Fellow Londoner Peter Denny, who let us know of his passing, writes "We are devastated by Greg's death, since he was the spark-plug behind just about everything that happened in this town."

CORRECTIONS

In the review of the CD **ECHO: The Images of Sound II** appearing our last issue (Dec '92), it was stated that Takehisa Kosugi's selection appearing on the CD was a piece using a fan, a radio transmitter, and a radio. These elements were used in an installation made by Kosugi, but the recording on the CD is of a separate performance piece using violin, flute, a ruler and Kosugi's voice, with contact microphones and additional small electronics. In Yoshi Wada's piece on the same CD, Yoshi Wada is joined in the performance by Terry Fox. The review's description of Joe Jones' piece "Small Orchestra" contained some inaccuracies; see Ernie Althoff's letter in this issue for details.

In Robin Goodfellow's article "A Hole is to Hit", also appearing in the December issue, due to a printer's error, the reproduction of Robin's scratchboard drawing of the African conical drum on page 26 was printed upside down. Robin reacted with good humor to this, but both the printer and the editor feel a little sheepish, to say the least, about the mistake. A right-side-up version of the drawing appears below.



Left: Robin Goodfellow's conical drum, right-side-up this time.

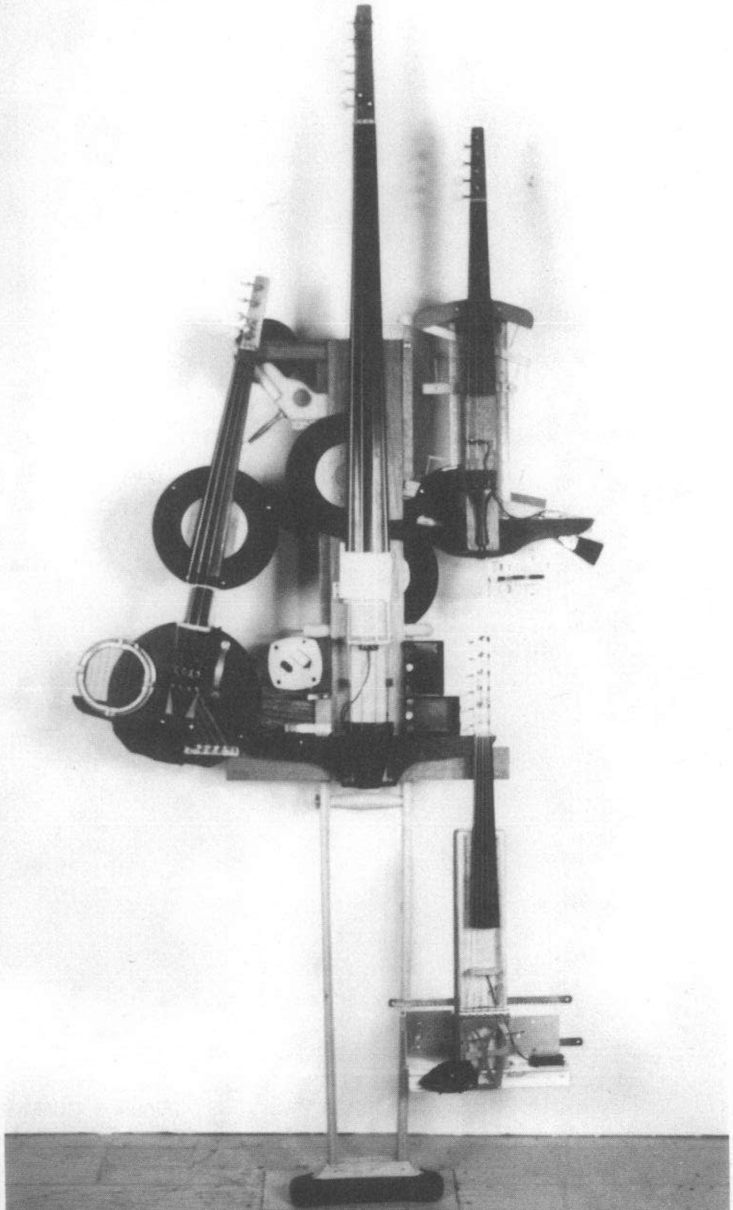
JOHN CAGE, 1912-1992.

A portrait celebrating John Cage's 80th birthday, from his last photo session.

Steven Speliotis Photography, 13-17 Laight St., F-2 #7, New York, NY 10013.

KEN BUTLERS'S HYBRID INSTRUMENTS

By Ken Butler



Ken Butler is a versatile artist/musician whose hybrid musical instruments, multi-media performances, and interactive sound installations have been widely exhibited across the U.S. and Europe, including the Stedelijk Museum in Amsterdam, and the Metropolitan Museum in New York City, as well as in Japan and South America. A resident of New York City, he studied the viola as a child, and maintained a strong interest in music while studying visual arts at universities in the U.S. and France. He has received numerous grants and awards, and his works are represented in public and private collections in the U.S. and Canada. He most recently exhibited over sixty of his instrment-sculptures at the Test-Site Gallery in Brooklyn, New York, including a grand piano made from bed headboards with strings strummed by small motors.

Ken Butler can be reached at 421 Wythe Ave., Brooklyn, NY 11211.

Figure 1 (above right): T-SQUARE QUARTET
Hybrid cello, viola and violins.

I created my first hybrid instrument quite by accident in 1978 by adding a fingerboard, tailpiece, pegs, bridge, and contact microphone to a small hatchet which I then played as a violin. I was working at the time in a variety of primarily visual media including painting, photo/collage, film and slide animation, and inter-active sculpture/light installations. The axe-violin, which I have played at hundreds of live performances since that time, was both my first sound piece and sculptural object, and further created the fusion of art forms and conceptual framework I was seeking – a transformative bricolage or hybridization of form and function and cultural object identity. Since that time I have created over 150 hybrid string (and a few percussion) instrument/sculptures in a variety of shapes and sizes, primarily from found objects and materials. I have also made numerous interactive sound and light installations, and given regular live performances. These range from solo concerts with a few instru-

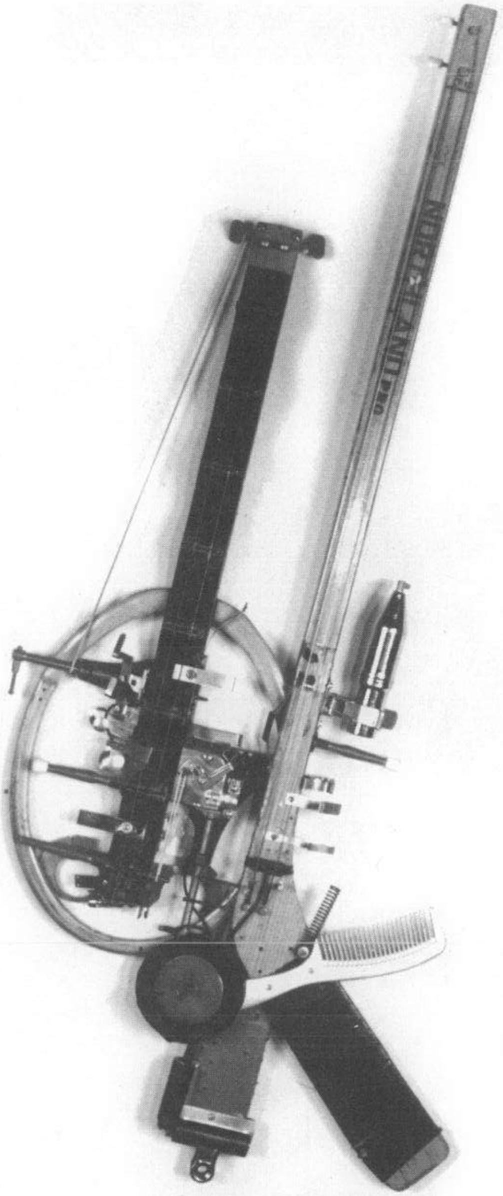


Figure 2: HOCKEY/RACKET

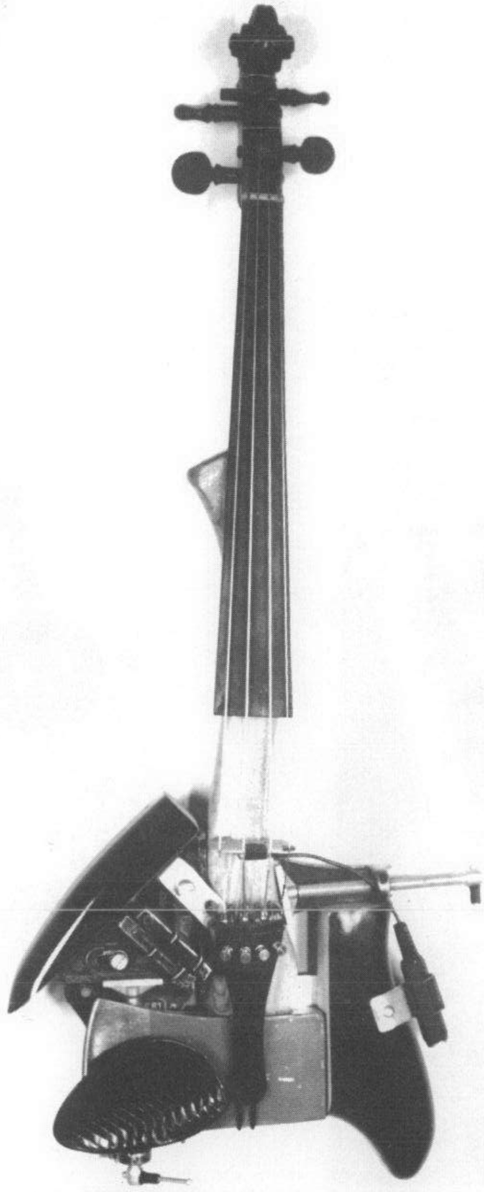


Figure 3: CLAMP/HATCHET

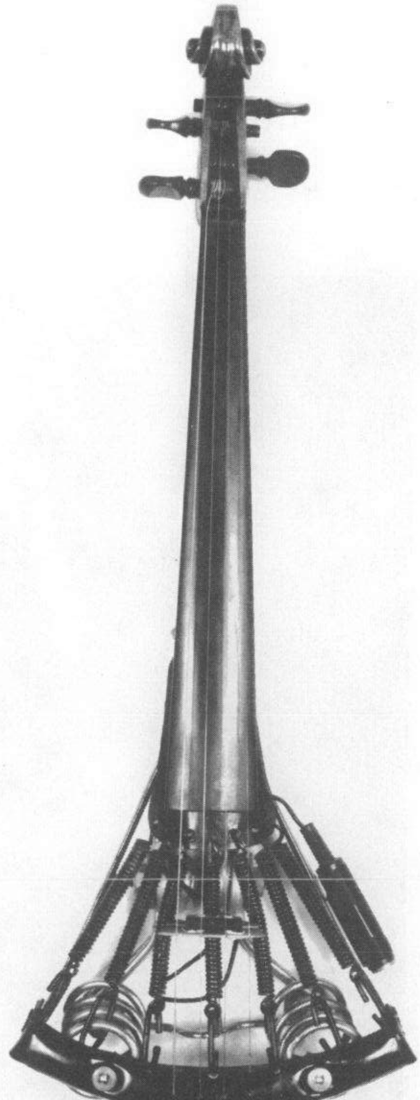


Figure 4: BICYCLE SEAT VIOLIN

ments to large-scale multi-media events with text, instrument-controlled multiple slide and kinetic shadow projections, thematic structure, and live music played on many hybrid instruments by several artist/musicians.

In this article I shall focus on the most recent group of hybrids constructed in the last two years and briefly discuss recent sound installation projects with an emphasis on the structure and playing methods of the instruments. Other issues such as musical composition and content and more in-depth artistic philosophizing are beyond the scope of this article.

One of the underlying themes in my work is that of hyper-utility – the desire for objects and images to work together in varying ways. The hybrids are both unique playable musical instruments and assemblage sculpture; they are constructed mostly from readily available objects made to perform a different function; they are built to human scale and even the largest pieces are designed to be easily transported and set up. Much effort has been spent on systems design to simplify the inherent logistical problems of performing regularly with over 15 instruments at a time.

One solution to the problem of portability versus sculptural presence (a constant hybrid dilemma) is shown in Figure 1, *T-Square Quartet*, a string quartet built recently for New York composer/violinist David Soldier. As I was interested in expanding the live events to a larger hybrid ensemble, I decided to build more conventionally scaled and "accessible" instruments, primarily violins and cellos. The four instruments fit together into a unified single piece to be deconstructed as the players take to the stage. The instruments (cello in center, viola at left, violins on right) were carefully constructed for both quality sound and visual interest from diverse objects and materials like t-squares, plastic film boxes, vinyl records, hardwoods, metals, and recycled fingerboards. Each piece has three surfaces using different resonant materials, enabling sound "tuning" by adjusting "bridges" between them. They also have extra bowing or plucking surfaces, strings, or devices (many of them kalimba-

Figure 5: MACHINE GUN VIOLA

Figure 6: GUN VIOLIN

Figure 7: HANDGUN VIOLIN

like). The first violin has six strings and a "floating" soundboard made from a section of metal stud. Multiple transducers amplify the sounds, as with all the hybrids. The instruments were used in the Soldier String Quartet's performance of David Soldier's *Bambatta Variations (String Quartet No. 2)*, December 3 1992 at Merkin Concert Hall, New York City.

Figure 2, *Hockey/Racket,* is made from a hockey stick with two bass strings and a tennis racket with a "scalloped" fretboard and two guitar strings tuned in octaves, along with multiple percussive devices and a swizzle-stick battery autostrummer. For playing as a "bass", the blade of the hockey stick fits neatly into your pocket. For violin-like bowing, the round plastic reflector serves as a chinrest. (Note that the photo is not to scale with the others on the page).

Figure 3, *Clamp/Hatchet,* is a violin made from a corner clamp and hatchet along with some fragments from a solid-body guitar. As with the bulk of the newer pieces it has a recycled neck and fingerboard. Much like my first axe-violin, the mass of the body gives extra sustain and tone quality to the instrument. Along the same lines is Figure 4, *Bicycle Seat Violin,* on which the bridge rests on springs – creating some unusual (and difficult to control) vibrations and warblings when amplified and bowed.

Figures 5, 6, and 7, *Machine Gun Viola*, *Gun Violin*, and *Handgun Violin*, along with Figure 13 *Rifle Cello*, form another very different string quartet (perhaps more pertinent for the Soldier String Quarter – however they are not all consistently playable and soundworthy). They are constructed from plastic guns (the rifle has a wooden stock) that are made to resemble actual weapons. As far as the artistic intent goes here, I will say that my examination of tools and hand-scale implements eventually led me to these elements. It would be difficult to find a single object more directly suited to the diverse requirements of a violin body (as far as shape) than the gun in Figure 5, and the dimensions of the rifle stock are exactly those of a cello body down to the angle for the tailpiece. It plays excellently and sounds great, and needless to say

Figure 8: CHAIR/AFRICA/BASS

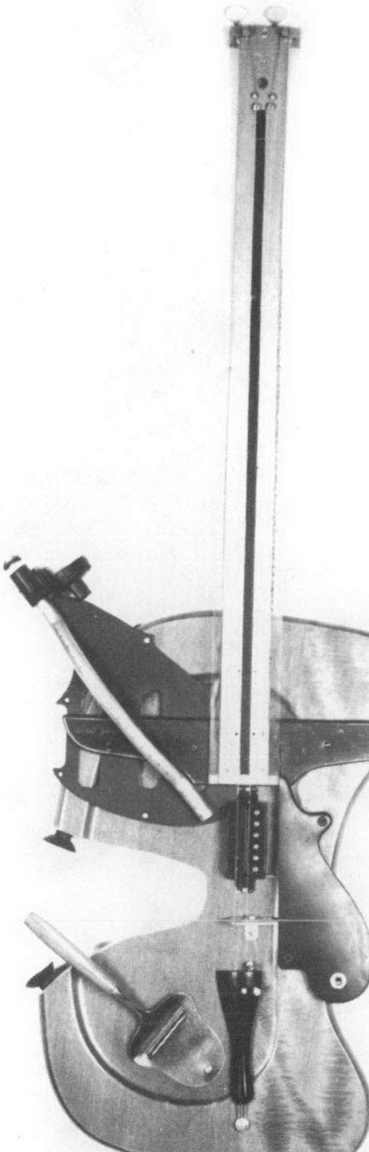


Figure 9: T-SQUARE/TRAY/CELLO

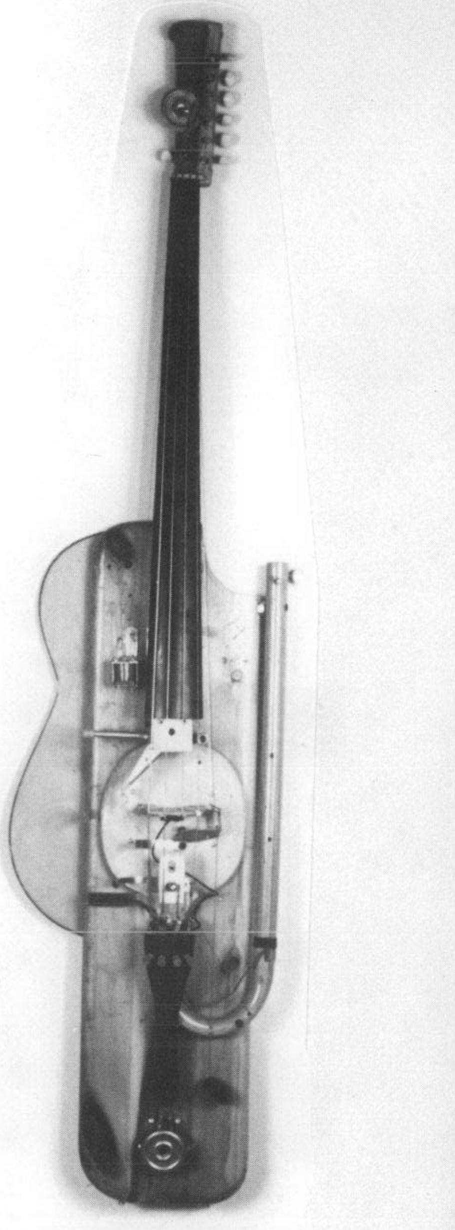


Figure 10: BASEBALL BAT/CANE/CELLO

makes for a dramatic stage presence. (Hoping not to be misunderstood, let me say, I have never owned or fired a real gun. I think of these pieces as a Dadaist prank in the spirit of Man Ray and Marcel Duchamp.) Figure 8, *Chair/Africa/Bass*, is an electric bass put together from broken chair and bass guitar parts, the bentwood legs calling to mind African animal horns. The piece is quite playable and was featured on the cover of the July 1992 Guitar Player magazine (for what it's worth).

Figure 9, *T-square/Tray/Cello*, is composed of a t-square, wooden high-chair tray, cheese slicer, and miscellaneous metal parts. The two strings are light-gauge guitar strings that are cello-length and are played by bowing or strumming. The extremely flexible neck allows for wild whammy-bar-like manipulations. As with the previous piece, I used recycled magnetic pickups. Figures 10, 11, and 12 (and 13) are all quite playable cellos with at least the four "regulation" strings along with additional elements.

Figure 10, *Baseball Bat/Cane/Cello*, has two extra strings as drones (or sympathetics) to the left side of the neck (a Louisville slugger), and one string on the right. The bridge rests on a ping-pong paddle, surrounded by other sound-producing devices. Figure 11, *Broom/Crib/Cello*, as well has additional strings and playing techniques such as bowing the edge of the guitar top, record, or small pivoting metal discs, or pulling on dental floss strings hanging from the bridge (this idea stolen from cellist Tom Cora). The bristles of the broom can be brushed or individually bowed. Figure 12, *Aluminum/Box/Cello*, has additional strings on an archery bow that functions as a large whammy-bar, along with the typical preponderance of sound sources.

Somewhat more like the bulk of the hybrids from late 80s, Figure 14, *Books/Fans/Constructivist*, is larger (5 feet high) and less functional. The emphasis is more towards the visual elements and design characteristics, though it produces interesting bowed sounds from its four strings. The edges of the various metal pieces can be bowed or plucked to produce a range of timbres.

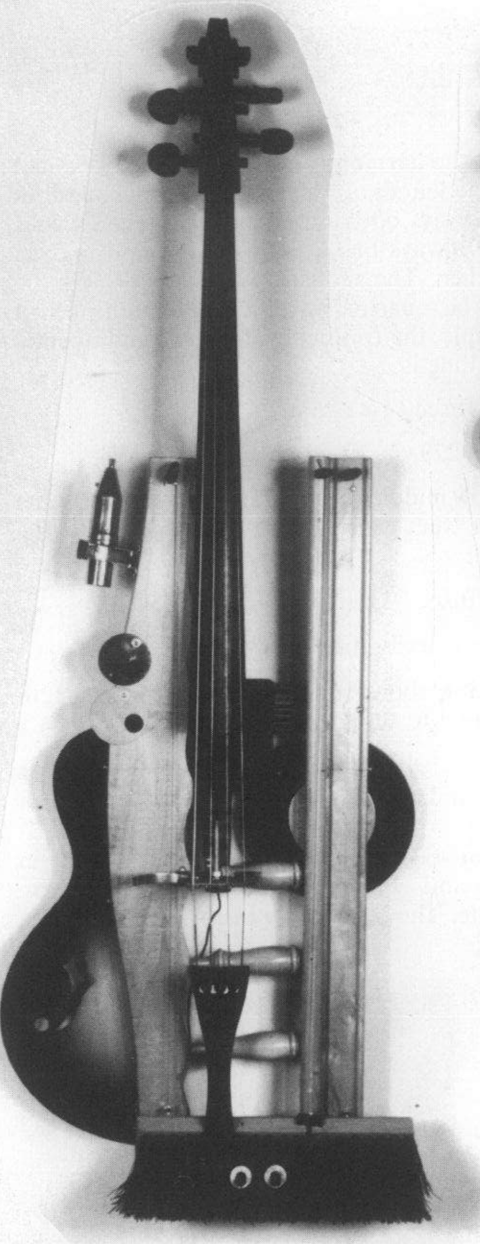


Fig. 11: BROOM/CRIB/CELLO

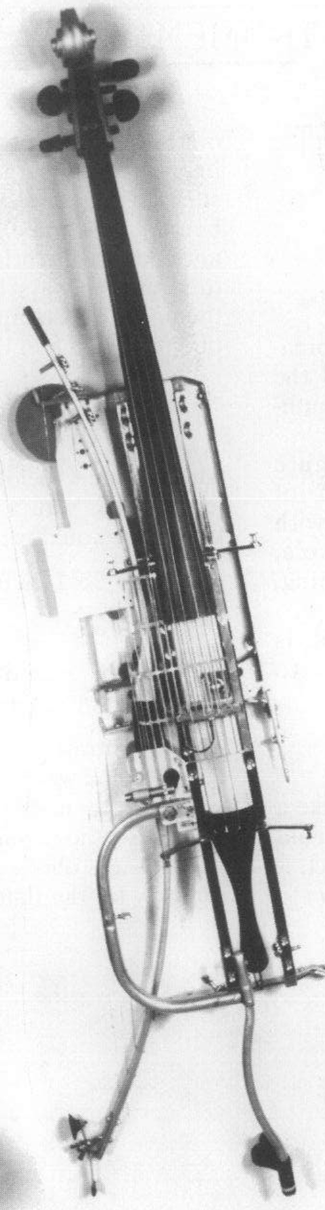


Fig. 12: ALUMINUM/BOW/CELLO

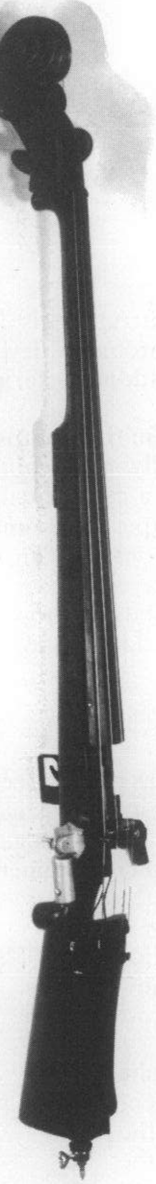


Fig. 13: RIFLE CELLO

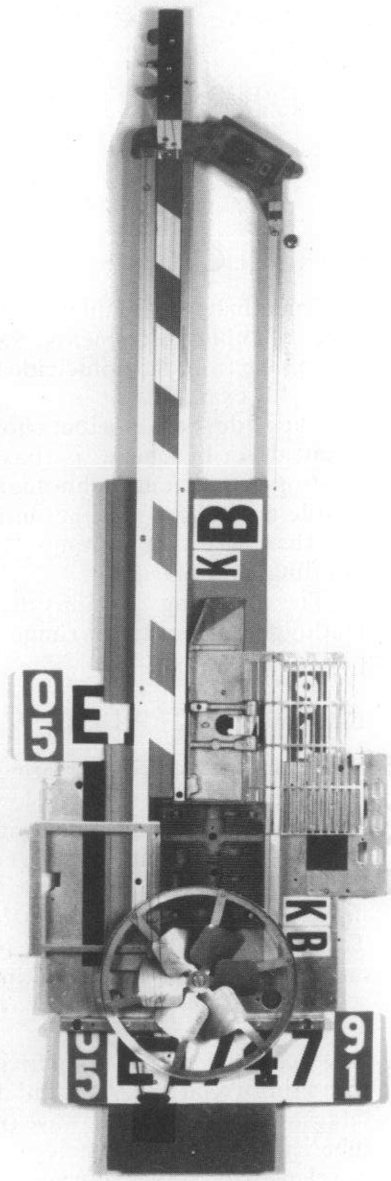


Fig. 14: BOOKS/FAN/CONSTRUCTIVIST

My interest in systems of control and the animation of light and objects stems from my experimental film making work from the mid 70s, essentially putting into motion my two and three-dimensional photo collage works by pixillation. A desire to free myself from the fixed speed of the finished film led to the use of multiple slide projectors eventually controlled by one of the hybrids to enable synchronous improvisatory sounds and images. This led to the construction in 1983 of a two-octave keyboard controller with micro-switches wired with a 60-foot cord to a remote 24-outlet electrical box which runs on AC. Operated by this keyboard, the installation works are essentially an "audio-visual piano" that creates a room-sized kinetic sound and projection environment. The viewer triggers a diverse group of devices including radios, tape recorders with loops, mechanical objects, slide projectors, light and kinetic shadow projections, and self-playing hybrid instruments. This dynamic and at times chaotic artwork is represented, if inadequately, by *Man's Angles*, installed at Generator Sound Art Gallery in New York City in January of '91. The piece incorporated about a dozen hybrid instruments. They were activated by small fan motors with "weed-eater" fishline strummers, or auto-strum devices made from LPs rimmed with guitar pics (with specific rhythm patterns) powered by gear motors. As to the use of relatively simplistic mechanical technology in the age of the omnipresent microchip, I was pleased to learn from a lecture about artificial intelligence that a live human with ten fingers remains the ultimate in high-tech creative control of diverse elements in an improvisatory manner.

In conclusion, I will use a quote from the Futurist artist Filippo Marinetti (a colleague of found sound inventor Luigi Russolo) from 1916 that still resonates for me: "A perpetual dynamic of thought, an uninterrupted current of images and sounds, is alone able to express the ephemeral, unstable, and symphonic universe that is forging itself in us and with us."

AN EXPERIMENTAL SLIDE BASS CLARINET

by Wes Brown

INTRODUCTION

Sometimes a seemingly new instrument is a combination of other instruments. Sax probably developed the saxophone from the ophicleide by adding a clarinet mouthpiece, for example.

The slide bass clarinet shown in the photos in Figure 1 and described here is basically a combination of existing instrument technologies, a cylindrical tube with a slide and a bass clarinet mouthpiece. Sounds simple, but there are a few things to consider in designing, building, and playing it.

The following sections describe it, show how it is made, give the musical range available, and tell how to play it.

DESIGN DESCRIPTION

Before this slide bass clarinet was built, it seemed like a good idea to make a simple, low cost instrument that could make solid bass sounds, even with a limited range. In fact, it was mostly intriguing because no other instruments seem to be able to slide around down in the nether depths of lower clarinet heaven. This possibility of being able to slide around down there, making new sounds was a special incentive to make it work.

A clarinet uses a cylindrical tube with a single reed which has a fundamental resonance as a quarter wave (i.e., the tube length is approximately 1/4 of the wavelength for the sounding frequency). This is shown on Figure 2. In this wonderful system, the reed acts like a closed end to the tube, causing a sound pressure node at the open end (the vibration causes no variation in pressure at this point) and a displacement node at the closed end (the vibration causes no displacement at this point). Antinodes are where maximum pressure variation or displacement occur, respectively. The term displacement refers to the actual movement of air. Figure 2 also shows what happens when the clarinet tube is vented, optimally at 1/3 the distance from the reed to the bottom, causing a harmonic overtone which is 3 times the frequency of the fundamental, a musical 12th. These relationships are described by the following equation:

$$f_n = nc/4L$$

where f is the frequency of the note, n is the number of the harmonic, c is the speed of sound in air, and L is the length of the tube. For closed tubes such as this, n is always odd and cannot take even values because the tube always has a node at one end and an antinode at the other. The acoustic waves enclosed in the tube must always be quarter waves or odd multiples of them. As an example, the frequency for the fundamental of a tube 1.25 feet long is:

$$f_1 = 1 \times 1100 \text{ ft/sec} / 4 \times 1.25 \text{ ft}$$

$$f_1 = 1100/5 = 220 \text{ vibrations per second}$$

which is an A below middle C on the piano. For the same length tube with a vent causing the first harmonic, the frequency would be:

$$f_3 = 3 \times 1100 \text{ ft/sec} / 4 \times 1.25 \text{ ft}$$

$$f_3 = 3300/5 = 660 \text{ vibrations per second}$$

which is the second E above middle C on the piano, a 12th above the fundamental A. Wonders never cease!

In contrast to the clarinet, cylindrical flute tubes generate half wave fundamentals and the first harmonic is an octave. Both ends are pressure nodes (no pressure variation), also shown on Figure 2. Conical tubes as used in saxophones, oboes and bassoons acoustically perform similarly to the flute. They generally resist operation in a

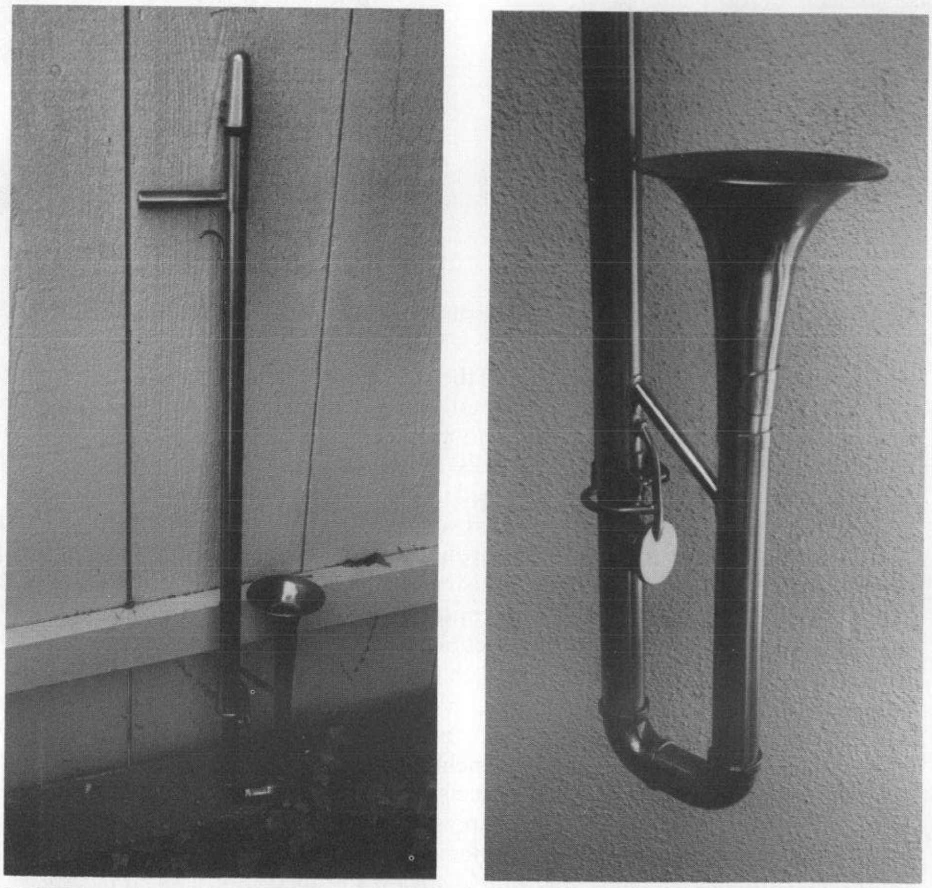


FIGURE 1: The slide bass clarinet, in full view and in a detail view of the single key.

clarinet mode, even when driven by reeds, although some double reed instruments rapidly switch back and forth between modes as a result of using special fingerings or because of leaks. These show up on the fingering charts as multiphonics. For a flute, the frequency formula is:

$$f_n = nc/2L$$

In this case, the harmonic designator, n, can take on both odd and even values, since both ends of the tube are pressure nodes or displacement antinodes. For a 1.25 foot tube, the frequency would be 440 vibrations per second or A above middle C with the first harmonic at 880 vibrations per second or second A above middle C.

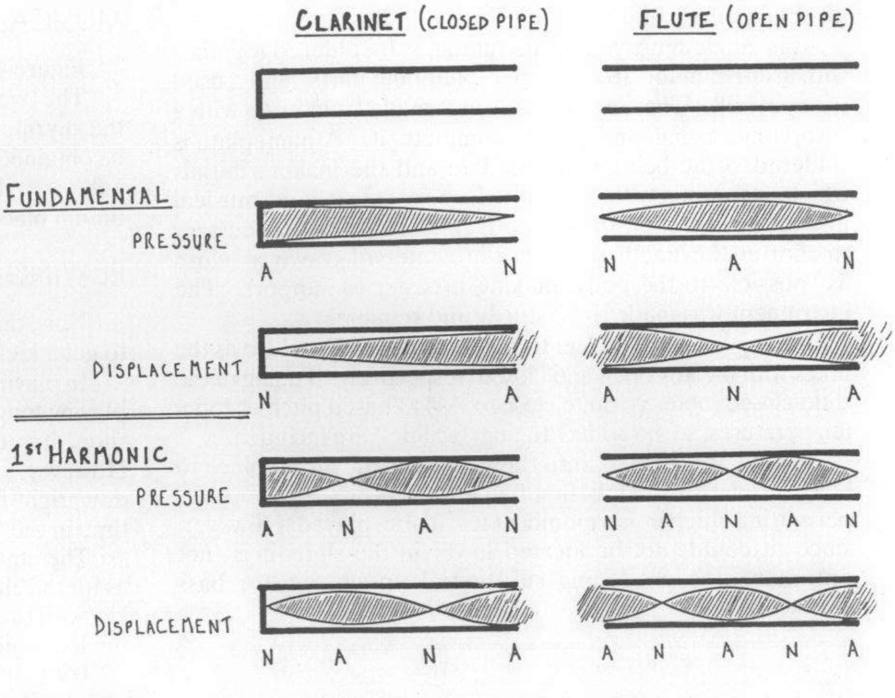


FIGURE 2: Acoustic waveforms for clarinet and flute. A = antinode; N = node.

Enough theory! Let's look at the instrument! Figure 3 is a diagram of the slide bass clarinet, showing the slide for note changing, a key for range changing, and the bell for coupling the sound to the air. The first issue to be concerned about in making such a slide clarinet is the range of the slide. For a slide clarinet type of instrument, doubling of the active length of the tube produces a change of an octave. Practically speaking, it would be less because some tubing is in the mouthpiece and some in the lower end, keeping the slide from falling off. A slide range of at least a fifth to a seventh should be enough.

Since the slide range is limited and could not provide an octave, it was decided to make the slide range in two parts, selected by a key.

The second issue with the slide is: can a range of a fifth or more be covered by movement of a player's arm? It was found that this is easily possible.

Next, we consider selection of notes for the instrument with the slide closed. Notes near the bottom of the bass clef seemed about right and, thus, F in this area was chosen for the key-open, slide-closed note and Bb for the key-closed, slide-closed note.

The length of the mouthpiece and top section which is not shortened by use of the slide is of interest. The longer this section is, the shorter the slide range becomes and the farther the player must reach. On the other hand, support and balance of the instrument are important, because the closer the right-hand grip on the slide is to the mouthpiece, the harder it is to hold the instrument up. In addition, there must be something for the left hand to hang on to. Thus, an outer tube of about four inches long was added just beyond the venthole as seen in Figure 3 for the left hand grip. The slide goes under this outer tube when closed all the way.

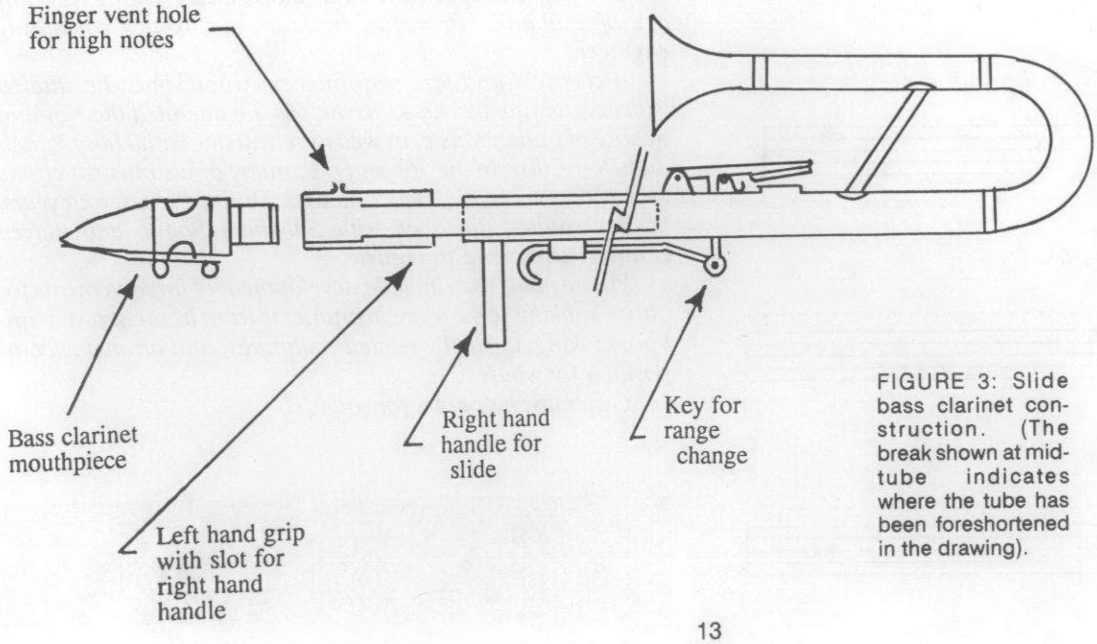


FIGURE 3: Slide bass clarinet construction. (The break shown at mid-tube indicates where the tube has been foreshortened in the drawing).

FABRICATION

So to work! How do we make this thing?

As seen on the photos in this article, the slide bass clarinet consists of a long one-inch tube, a single large key, a curved section to shorten the length, a bell for acoustic coupling to the air, and a standard bass clarinet mouthpiece to generate sounds. If it were taken apart, it would be three pieces, the mouthpiece, the inner slide with the support handle, and the outer slide with the lower

tube, key, curve, and bell.

It is made mostly of brass tubing, soft-soldered together with a curve made from copper plumbing parts, and a used trumpet bell. The key mechanism is made from brass with a saxophone spring and pad to complete it. A nameplate is soldered to the bell giving the date and the maker's initials which, together with a coat of epoxy clear gold musical instrument lacquer, finish it off. The curve was necessary to shorten the length to move the center of gravity as close as possible to the body, making it easier to support. The instrument was made to be sturdy and reliable.

Tubing lengths were cut to fit the choice of F and Bb as the notes with the key open and closed, respectively. Tuning of the slide-closed notes is quite close to A-440-based pitch at room temperatures, so no added tuning facilities are included.

A hole was drilled into the tube near the mouthpiece to be covered with the left first finger. It acts as a register hole, permitting higher harmonic notes to be played. However, since it could not be located lower in the slide, it is not optimum for producing substantial upper register bass clarinet notes.

FIGURE 4: Slide bass clarinet ranges

MUSICAL RANGE

Figure 4 shows the tuning ranges obtained.

The two lower ranges are fundamentals with and without the key open. The second register, and a third above that, can be obtained by means of the small register hole. These higher notes are thin and difficult to find because of the non-optimum placement of the register hole.

PLAYING TECHNIQUE

Now, this is no laughing matter, although everyone seems to get a kick out of it.

In playing the instrument, it is kept close to the body when playing long tones in closed positions. With extension of the slide, it is easier to hold it up and it can be held farther out. However, regardless of how you hold it, it could get downright fatiguing if you are playing slide bass clarinet full time in the Carpal Tunnel Syndrome Symphony Orchestra.

The embouchure and the use of the tongue are the same as for the clarinet. Range changes are made by operating the key with the first finger on the right hand and, of course, with the left hand first finger hole..

It's easy to get some interesting sounds but it is not so easy to play tunes on it. Repeated notes are easy and fifth changes between the ranges are easily done with the key. To play a simple scale in tune is somewhat harder, although practice might make it better.

The most unique feature of this instrument is its ability to produce sliding or continuously variable low notes with a bass clarinet sound. In fact, it has a fabulous sound.

There has not been a big demand for this instrument. In fact, gigs are really nonexistent. Yet, the sounds that can be made are not possible to make in other ways, even with modern synthesizers. I believe it could be a contributor in some modern compositions or even in special sounds for monster movies. Perhaps the makers of future Godzilla or Rodan movies will come through with a recording offer!

Wes Brown is an electrical engineer who has worked on communication satellite systems for Hughes Aircraft and design of spread spectrum data radios and banking technology of Citibank. Presently, he is an electronics consulting engineer.

A classical and jazz performer on woodwinds, he studied with several fine teachers. In the 60s, he attended the Kinnara School of Indian Music, as well as rehearsing with Harry Partch and Don Ellis. In the 70s and 80s, many of his musical efforts were with commercial dance bands. During the last four years, he has studied the oboe with Salvatore Spano and played chamber and orchestral music.

Future plans may include development of improvements for oboes, making some more instruments from home-grown bamboo, making musically-related sculptures, and arranging/composition for winds.

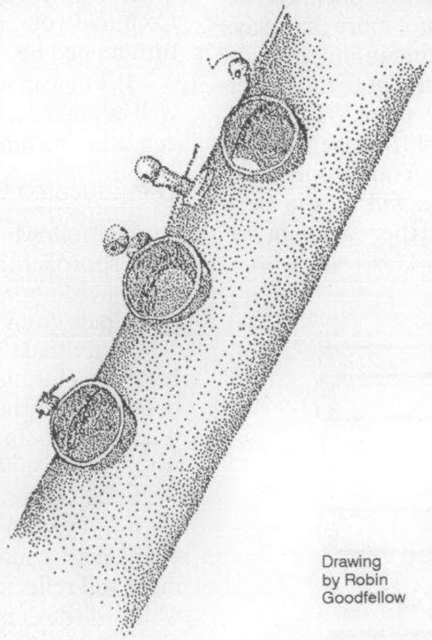
Generally, he's crazy for sounds!

WIND INSTRUMENT TONEHOLES
Part 1

By Bart Hopkin

EMI recently presented a two-part article on wind instrument bore shapes and their acoustic behaviors [see EMI Volume VII, Numbers 5 & 6]. Continuing the series on practical wind instrument acoustics, we follow now with another two-parter, dealing this time with wind instrument toneholes – their placement, sizing and general design. The more technical parts of the toneholes article will lean upon ideas presented in the earlier bore shapes articles, and some readers may find it valuable to look those over as an aid to following the ideas presented here.

Part one for the most part will be theoretical, outlining some rules governing toneholes and their acoustic effects. The coming second half focuses upon the actual making of toneholes at the most practical level. The material may be a bit dense in places. For readers seeking a simpler and more readable, but highly practical, account of the same acoustic forces at work, I recommend the booklet **Simple Flutes: Make Them, Play Them** by Mark Shepard (available from Tai Hei Shakuhachi, PO Box 294, Willits, CA 95490).



Drawing by Robin Goodfellow

INTRODUCTION

The number of home builders making wind instruments is relatively small, compared to those making, say, string or percussion instruments. One reason is that wind instruments and their acoustic operation are more difficult to comprehend and visualize. Another is that, while the manufacture of very simple woodwinds is feasible for many people, creating more sophisticated winds seems to call for equipment and expertise that are not available to most people. Toneholes are part of the problem. With small woodwinds, you can easily put a few holes in the body of the instrument and come up with something that is playable with the bare fingers. But when you set out to make a woodwind instrument of greater size and lower range, the picture changes. To draw a good sound out of a larger instrument, the toneholes need to be larger than what a bare finger can cover. They also need to be spaced farther apart than the player's hand can reach. The solution to these problems, a glance at classical woodwinds tells us, is to use levers and pads to cover the larger holes and bring the action within reach of the fingers. But the keying mechanisms on classical woodwinds are sophisticated affairs. To create a mechanism of comparable precision and complexity in a home workshop is an intimidating prospect.

The problems compound as the number of toneholes increases. A simple flute of five or six holes is one thing; quite another is an instrument with separate fingerings for a full chromatic scale, and controllable register changes for an expanded range. New factors come into play that affect the placement of new holes; they also throw off the tuning of previously-made holes; and they often undermine playability, tone quality and range of the instrument.

This article won't eliminate those difficulties. I hope, though, that it will make the overall picture a little more comprehensible, and the challenges a little more manageable.

TONEHOLE PLACEMENT

The holes that appear along the sides of wind instruments do what they do by shortening the effective vibrating length of the tube, causing the air within to vibrate at a higher frequency than would the full tube length of air. It's easy to picture this by imagining that an open tonehole is like a premature end to the tube: a pressure wave front running the length of the tube, which would usually partially reflect back into the tube at the open end, instead reflects when it encounters the open tonehole. The wavelength is shorter as a result, and the frequency higher. This picture would be roughly accurate if the tonehole happened to be as large as the tube diameter. That's not impossible, but it is awkward to have a hole that large.

A more common situation is that the tonehole is smaller than the tube diameter. To begin to understand what happens then, we need to review the air pressure situation within the tube. Most of the air within a hole-less tube experiences an ongoing oscillation of air pressure when the air is set in vibration. That is to say, the pressure at each point within the tube undergoes recurring change, rising above then falling below the atmospheric norm. The intensity of this oscillation diminishes near the open end of the tube, because there the air is freer to accommodate surrounding pressure changes by moving in or out of the opening. Rather than undergoing the full pressure variation, it undergoes greater motion – vibrates with greater amplitude – instead. At a location just beyond the open end of the tube we arrive at a pressure node: a point of negligible pressure variation, and maximum movement.

Now if we place an opening along the wall at some point, the air's ability to build up pressure at that point is undermined, just as it is at the open end. Instead, the air partially accommodates each momentary pressure buildup by simply moving in or out of the hole. When the hole in the tube is as large as the tube diameter, the venting of the pressure will be sufficient to create a pressure node and displacement maximum just outside the hole, just as at the open end. But if the hole is smaller, a lesser venting occurs. Not all the pressure is converted to motion. The effect is that, while the enclosed wavelength is not cut off as drastically as with the full-sized hole, the overall waveform within the tube is altered, and a shorter effective standing wavelength arises within the overall tube. The frequency is higher than the hole-less tube would produce, but lower than what would be produced by a full-sized hole at the same location.

How much shorter than the full-tube wavelength is the effective wavelength, and how much higher the sounding pitch? This depends upon how much venting occurs. The degree of venting depends primarily upon how large the hole is relative to tube diameter. There are number of other secondary factors as well, which we'll soon be outlining. In practice it turns out to be extremely difficult to make accurate predictions as to what the sounding pitch will be for a given configuration of open toneholes. The mathematics are complex, and several agonizingly subtle measurements are required to give values to the variables the equations call for. It is possible, however, to do some informed estimating. With this in mind, let's take a closer look at the possible approaches to intelligent tonehole placement.

Possible Approaches – from Guesswork to Calculation[1]

You may be able to get away with ignoring the mathematics and simply proceeding with tonehole making by instinct, trial and error, and subsequent fine tuning. This is especially true for instruments with relatively few holes – not more than, say, five or six. The key lies in the process of fine tuning by hole sizing. For any given hole location along the tube, the larger the hole, the higher will be the sounding pitch. The best approach is to make the lowest tonehole first (the one farthest from the mouthpiece), and work upwards. You can proceed by making a small hole at what you guess will be the best location to produce the intended pitch, and then listening for the resulting pitch. Hopefully, given the small hole size, it will be low. You then gradually increase hole size to bring the thing up to pitch. Then proceed to the next hole, and the next and the next. Each new hole affects the pitch of the existing lower ones (in a manner we'll describe momentarily), but with luck the effect will be negligible, or at least small enough to be corrected by a second round of fine tuning over all the holes.

That said, the fact is that it helps a great deal in this process if you have some practical guidelines for deciding where to drill the holes in the first place to produce the best result. There are several approaches to this problem.

1) You can follow a standard pattern of some sort, such as the widely-used pennywhistle fingering given on this page, or copying from an existing instrument. If you do the latter, you must be sure that the air column of the new instrument matches that of the prototype in all dimensions.

2) You can make a series of instruments with identical tube dimensions. Make all your mistakes and attempted corrections on the first; incorporate your best results into the second. Continue your refinements through a third and fourth and fifth if need be.

3) You can use your knowledge of acoustics to estimate, as well as possible, what the locations should be, knowing that you can later fine tune through adjustments in hole size and depth.

The Educated Estimate

The following paragraphs contain guidelines to help you with approach number three. Even if you choose another approach, it's a good idea to familiarize yourself with the principles given here.

Notice that these principles are mostly concerned with finding a good location from an acoustic point of view. But remember to keep the human player in mind: it doesn't help to have the tonehole out of reach of the finger that is to cover it. You can, within limits, shift hole locations to suit the human hand, through the trade-off between hole size and hole location.

For cylindrical tubes, begin with the knowledge that wavelength is inversely proportional to frequency. Hole placement will reflect this – but only in a very preliminary fashion, which will be drastically altered after other factors have their say. To illustrate: Imagine that you want to place a tonehole so as to produce a tone, let us say, a minor third above the full-tube-length tone. The hole location would *in this preliminary assessment* be located 5/6 of the full tube length, to produce a frequency of 6/5 the full tube's frequency. (This frequency ratio produces the interval that the ear hears as a minor 3rd. If you're not sure what the frequency ratios are for the intervals you want to produce, you can consult the chart that appeared in EMI Volume

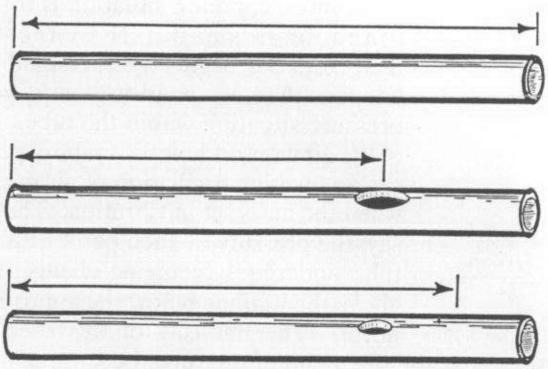
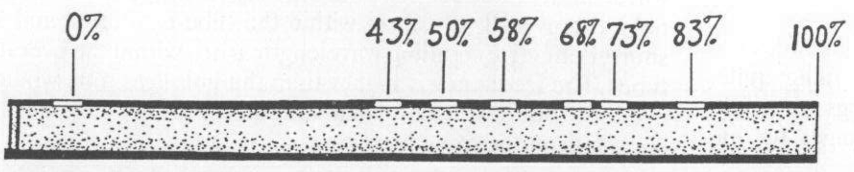


FIGURE 1 (above): Effective tube lengths resulting from toneholes of different sizes. Top: No tonehole; effective length is full tube length. Middle: Tonehole as large as tube inside diameter; effective tube length ends at tonehole. Bottom: Smaller tonehole; effective tube length ends somewhere between the tonehole and the end of the tube.

FIGURE 2 (below): Standard Pennywhistle Fingering. The hole spacings given here opened in sequence will yield major scale. By means of cross fingerings (covering one or two holes below the first open hole) they will yield all of the chromatics as well, except the minor second. By uncovering or half-covering the highest hole while closing those below it, you can throw the flute into its second register at the octave, to extend the range upward several more tones. All spacings are from the centers of the holes. These hole spacings will work for flutes over a wide range of lengths, assuming that the bore is uniformly cylindrical. Recommended bore diameter -- 11/16" for shorter flutes to 1" for longer; recommended hole size 3/8" for smaller bores to to 7/16" for larger bores. (From Mark Shepard, **Simple Flutes: Play Them, Make Them**)



1. In the following discussion on tonehole placement, keep this is mind: In normal wind instrument playing, you rarely have a single large tonehole opened somewhere up near the middle of the tube, with no other openings below. Instead, when a hole far up the tube is opened, all or most of a row of toneholes below are left open as well. There are two reasons. One: the additional open toneholes help vent the sound, making for better volume. The other: when there is a single large open tonehole far up the pipe, then the portion of the tube below the open hole behaves as a semi-independent air column in its own right. This creates an acoustically anomalous situation, with two quasi-separate air columns abutting one another and potentially interfering with one another's operation. Leaving open the series of toneholes below precludes this problem by breaking up the lower column. In this article we will operate on the assumption that toneholes appear in a series, and holes below the first open one are normally left open.

VI #2, or any number of other sources.)

An alternative approach to this first step is simply to calculate the wave length for the desired pitch at each tonehole. Your preliminary location estimate will be such that the distance from the center of the hole to the mouthpiece or blowhole is either 1) half that distance for flutes and other tubes open at both ends; or 2) one fourth that distance for lip buzzed instruments, reeds, and other instruments stopped at one end. (For information on calculating wavelengths, see the chart in EMI Volume IV #5, or any number of other sources.)

Whichever method you use, recall that this initial hole location represents only a very rough first approximation. Now we begin to apply other considerations. Below is a list of factors to be taken into account. Taken together, these factors will yield an estimate for how much farther up the tube the hole should be, compared to the initial location just arrived at. That distance we will give the label *C*, short for tonehole *Correction*. The tonehole correction, in short, is the distance the tonehole should be displaced up the tube from its simple-ratio location.

The first three factors listed here have the effect of lowering the sounding pitch below what one would predict based on the simple ratio calculation. To compensate, you move the theoretical hole location upward on the tube (closer to the mouthpiece), thus offsetting their pitch lowering effects and achieving something close to the intended pitch. The fourth factor below has the effect of lessening the pitch-lowering effects of the other factors. You take this into account by reducing the amount of upward displacement you would otherwise have made on their account. Here, then, are the several factors:

1) SMALLER HOLE → LARGER CORRECTION.

This is the factor with the most substantial impact. Presumably the ultimate hole size will be smaller than the tube diameter, meaning that the sounding pitch will be lower than the initial prediction. To compensate, shift the theoretical location *up* the tube.

How much to shift depends upon how much smaller than the main tube diameter you want the hole to ultimately be. The degree of displacement is proportional to the ratio of the tube's internal diameter to the hole diameter. For a more precise reading on this, go on to #2.

2) THICKER HOLE → LARGER CORRECTION.

The tube wall has some thickness, which means that the hole has some depth. If there are to be walls built up around the hole to make a good seating for finger or key pad, they will add to the depth. That hole depth, commonly referred to by the letter *t* (for thickness), functions like a bit of additional tube length, lowering the pitch relative to the predicted value. Shift the hole estimated hole location farther up the tube for thicker holes; less far for shallow holes.

For a slightly more accurate reading on this, you need to consider not the just the hole thickness, but the *effective* hole thickness t_e, which takes into account the fact that the open tonehole has its own end-correction factor. t_e typically ends up roughly equal to the hole thickness plus just over half the hole diameter. For those who like to see numbers, a formula for a reasonable approximation is

$$t_e \cong t + 0.8\, d_h - 0.5(d_h^2/d_p)$$

where d_h is the diameter of the hole and d_p the diameter of the pipe.

Again for those who like numbers, we can now suggest a simplified, approximate formula that takes into account both tonehole size (from #1 above) and thickness. The tonehole correction from these two factors alone should approximate the ratio of the tube's internal diameter to the hole diameter, multiplied by the effective thickness of hole:

$$C \cong t_e\,(d_p/d_h)^2 - 0.3\, d_p$$

3) MANY LARGE CLOSED-TONEHOLE CAVITIES ABOVE THE FIRST OPEN HOLE → SLIGHTLY LARGER TONEHOLE CORRECTION.

Closed toneholes located above the tonehole in question tend to lower the sounding pitch slightly. The reason is that closed toneholes typically enclose a small pocket of air in excess of what a perfectly uniform tube would hold, increasing the total volume over that of an ideal tube. The effects of this on specific pitches are variable and hard to predict. But typically the effect is to lower the sounding frequency by a percentage that is less than the percentage increase in volume from the closed toneholes. So, in situations where there will be closed toneholes above, compensate by shifting the theoretical location up the tube by an amount less than that percentage of the mouthpiece-to-tonehole distance. But since that percentage will be hard to measure or guess in advance with any accuracy, you might do just as well to just nudge the estimated location up a tiny bit.

4) ADDITIONAL OPEN TONEHOLES BELOW THE FIRST OPEN ONE → SMALLER TONEHOLE CORRECTION.

Except with very large holes, the pressure venting effect of the first open tone hole that the wave encounters – the one farthest up the tube – is not the whole story. Since the hole releases only part of the pressure, the pressure wave continues down the tube beyond it. If it encounters other open holes farther down, they will join in the venting function, for an effect similar to increasing the size of the original tone hole. The result is to counteract the pitch-lowering effects of factors 1 and 2 above, bringing the sounding result a little closer to what it would have been had the tube simply ended at the point in question. Thus, in situations in which there will be additional open tone holes below the one in consideration, accommodate by reducing the upward displacement suggested by factors 1 - 3.

Where the primary hole is quite large -- say over 75% of the tube diameter – most of the venting takes place there, and the pitch lowering effects of factor 1 are fairly minor. In that case, the presence of additional lower open tone holes makes only a small difference. At the opposite extreme, where the primary hole is less than, say, 40% of tube diameter (as with the smallest recorder hole), a relatively small amount of venting takes place at the primary hole. Then the pitch lowering effects of factor 1 can be quite pronounced, and the additional venting afforded by the lattice of lower open toneholes becomes quite significant. This leads us to these subsidiary rules:

a) The smaller the primary hole, the greater the reduction of the tonehole correction factor due to additional open tone holes.

b) The larger and/or nearer the additional open tone holes, the greater the reduction of the tonehole correction factor.

5) The above descriptions have been for cylindrical tubes. For conical tubes, compensation must be made for the fact that the waveform within the tube takes an irregular shape. For normal conical tubes, one must shift the preliminary theoretical location down the tube by an amount that depends on the rate of expansion. For reverse conical tubes such as recorders (in which the

tube becomes smaller toward the far end), the same reasoning will lead to shifting the theoretical location up the tube.

Even with these rules to work from, trial and error will continue to play a substantial role for most builders, along with a generous dose of later fine tuning through hole size adjustment. This is especially true during one's early attempts: there's nothing like experience to learn how to weight these factors and improve one's instincts. A frustrating part of the process lies in the fact that as you add more toneholes, you throw off the results of holes already in place, due to factor #3 above. True, the effect is a usually flattening one, so you can later go back and correct with another round of slight hole enlargements. Sounds simple enough, but in practice it can drive you crazy. The fact is, it's easy to ruin an instrument as each additional hole requires further modifications of existing holes, and each of those modifications affect still other holes. When you add in factors like a human inconsistency of embouchure – meaning that the sounding pitch varies from toot to toot even when the instrument itself is unchanged, due to subtle changes in the way one happens to blow – the hope for mathematical precision in this business begins to fade. But the real killer is the ever-present possibility of sabotage in the form of an air leak at an improperly covered tonehole somewhere. This drastically affects the sounding results, and it can easily occur without the player being aware of it. All of these difficulties compound themselves exponentially as the total number of toneholes increases. Happy are those who are content with five and six note scales.

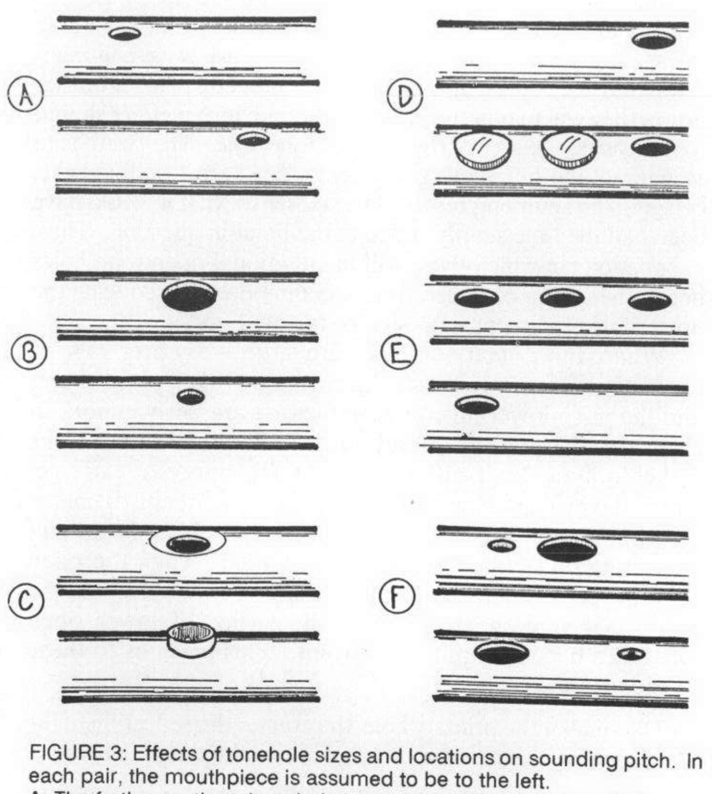


FIGURE 3: Effects of tonehole sizes and locations on sounding pitch. In each pair, the mouthpiece is assumed to be to the left.
A: The farther up the tube a hole is, the higher the resulting pitch.
B: The larger the hole, the higher the pitch.
C: The shallower the hole, the higher the pitch.
D: Covered toneholes above the first open tonehole have the effect of lowering the pitch slightly.
E: Additional open toneholes below the first open tonehole have the effect of raising the pitch.
F: The smaller the first open tonehole is, the more it will be affected by additional open toneholes below. The larger and nearer the additional open holes below, the more they will raise the pitch of the first open tonehole.

Formulas

Now, for those who are willing to do more math in order to reduce their reliance on guesswork and later corrective work, here is a more comprehensive mathematical approach. Arthur H. Benade, in his **Fundamentals of Musical Acoustics** (New York: Oxford University Press, 1976), pulls together all the considerations discussed above, in a pair of companion formulas. The results they produce are approximations, but to do better would require a heroic amount of both measurement and math. Benade's approach is to find a value for *C*, the tone hole correction. Benade's definition of *C* differs slightly from the approach we used above (it actually matches the physical situation a bit better), but the effective difference between the two is quite small. Benade's *C* represents the distance farther up the tube that the tone hole must be located, as compared to the point at which the tube would have to be cut off to produce the same pitch. In accounting for the effects of open toneholes below the primary hole, Benade makes two simplifying assumptions: 1) that the toneholes in the series are more or less equally spaced, and 2) that they roughly equal in size. Where tonehole size varies by less than 50%, the formula remains reasonably accurate.

And here I must add a personal disclaimer. In my own experiments, I have been unable to make these formulas work. They consistently produce values for *C* that are substantially too large, leading me to place the tonehole too far up the tube. Whether this is because I have somehow misunderstood or misused the formulas, or because anomalies in measurement, embouchure or other factors have thrown off the results, or because the formulas themselves are somehow flawed, I don't know. But I present them as they appear in Benade's writings, and wish you luck with them.

Benade presents two formulas. One of them, in theory, works well at low frequencies. It becomes slightly inaccurate through the mid-range (the results err increasingly on the low side), and only becomes seriously inaccurate near the highest pitches in the instrument's spectrum (which usually are present only as overtones anyway). He then presents a second formula showing the maximum value that *C* approaches at the instrument's highest frequency. Here's the lower range formula, starting with definitions for the variables:

Where C_{low} is the tonehole correction factor (described above) for pitches through the low and mid-ranges, and

r_p is the internal *radius* (not diameter, note) of the tube at the location of the primary hole, and

r_h is the *radius* of the primary tonehole, and

s is 1/2 the distance between the centers of the primary tonehole and the next one below it (i.e., the distance between the tone hole centers is 2s), and

t and t_e are the thickness and effective thickness of the tonehole (defined in item #2 above), THEN:

$$C_{low} = s\sqrt{1 + 2(t_e/s)(d_p/d_h)^2}.$$

The second formula, giving the tone hole correction at the maximum frequency, reads:

$$C_{max} = s\sqrt{2.759\,(t_e/s)(d_p/d_h)^2}.$$

The formulas are only meaningful in cases where there is

at least one additional tonehole open below the primary hole (otherwise the variable s is undefined). For the remaining case – that of just one open hole – you can turn to the simpler formula (from item #2 above):

$$C \cong t_e\,(d_p/d_h)^2 - 0.3d_p.$$

The C_{max} formula is the less important of the two, serving primarily to indicate how far off the C_{low} formula may be at the maximum as one reaches into the upper ranges. Benade observes, "On most woodwinds C_{max} is seldom more that 50% larger than the low-frequency value C_{low}; at three quarters of the cut-off frequency, however, C increases only 12% or less." He later adds "If more exact results are needed or if the lattice [of open toneholes] is very irregular, meaningful calculations can be carried out, but they become extremely tedious and fairly subtle." He recommends Cornelis Nederveen's **Acoustic Aspects of Woodwind Instruments**.

If you study Benade's formula you'll see that it says all the same things that items 1 through 4 above do, but of course far more concisely, and with the considerable advantage of generating what one hopes will be usable numeric results. For most standard woodwinds the approximate tonehole correction factor indicated by C_{low} typically works out to be between $1.5s$ and $4s$, which is to say, from a little less than the typical distance between toneholes to about twice that.

ADDITIONAL EFFECTS OF TONEHOLE SIZE AND THICKNESS

Up to now we have considered tonehole diameter from the point of view of its effect upon sounding pitch alone. But the size of the toneholes has important effects upon the overall timbre, volume and playability of the final instrument as well. We'll discuss those effects now. As we do so, remember that changes in tonehole size and tonehole thickness are similar in their effects: thickening the hole is functionally like reducing the diameter. The observations about reducing hole size that follow here apply just as well to increasing thickness, and vise versa.

To begin with, tonehole size has a very substantial effect upon volume. Large toneholes make for better volume, because they afford more "surface area" from which the sound can radiate. Saxophones have huge toneholes and great volume; recorders have small toneholes and poor volume. One of Theobald Boehm's innovations in creating the modern orchestral flute was to enlarge its toneholes to something close to the largest feasible size, at about 3/4 of tube diameter, and the resulting instrument is correspondingly louder than earlier flutes. Recorder toneholes, by contrast, are considerably less than half the tube diameter, and the resulting sound is rather weak.

For instruments designed to overblow the octave or twelfth, playing through two or more registers, very large toneholes have a slight advantage over smaller ones in the area of register tuning. The common problem of flatness the upper registers is more pronounced with smaller toneholes.

If these things make the idea of larger toneholes seem attractive, don't forget that your instrument player will probably be human, with human-sized fingers. If the holes are to be covered directly with the fingers rather than by a key-and-pad mechanism, larger holes will be harder to cover leaklessly. Even with pads, the requirements are more exacting for a faultless seal over a larger hole. In addition, larger holes usually mean larger closed-tone-hole cavities and generally more disruption of bore shape along the air column. And since the pads or fingertips that cover the holes are softer than the tube walls, problems associated with increased damping may also occur, possibly dulling an otherwise well-defined resonance peak in the tube, lowering pitch, or weakening the high frequencies.

Finally, recall that with larger toneholes most of the pressure vents at the first open hole. This means that forked-fingerings are less effective. Forked fingerings are fingerings which leave one open hole but cover the next, such as the soprano recorder fingering for Bb, xxoxoooo (x = closed tonehole; the first x represents the thumbhole). Covering the next hole below the primary open hole lowers the pitch, in this case, from B to Bb, because enough of the pressure wave has continued down the tube past that first small open tonehole so the closing of the next hole makes a significant difference. If all the venting took place at the first hole, this would not be the case. Forked fingerings may seem awkward, but they do have this great advantage: they allow a greater number of pitches with fewer holes than would be the case if each pitch demanded its own separate hole.

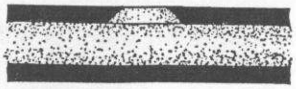
To sum up: larger tone holes are preferable in most respects, but using them creates a need for more holes, more sophisticated keying mechanisms, and more exacting craftspersonship than what you could get away with using smaller holes.

Another very significant effect of hole size has to do with what Benade calls the "cut-off frequency". Recall from the earlier articles on bore shape that soundwaves travelling in a tube partially reflect back into the tube when they reach an open tube end or tonehole, and partially propagate out into the surrounding air. Just how much of the energy of a particular wave reflects back and how much escapes is a function of the size of the opening and the wavelength of the wave. The larger the tonehole diameter relative to wavelength, the more of that wave's energy will escape and not reflect. There comes a point for very large toneholes and very short wavelengths at which virtually all of the wave's energy passes out through the tonehole. It might seem that the frequencies for such short wavelengths, radiating out through the tonehole with near 100% efficiency, would sound especially loud. But with no reflection occurring, it's impossible for standing waves to be set up within the tube at those wavelengths. The result is that nothing much happens at or above that frequency range in that particular tube. In short, for a given open tonehole size, there is a certain cut-off frequency above which the instrument does not function. That frequency is usually well above the frequencies of the instruments' fundamental pitches, and so the cut-off frequency has its affect primarily on the high overtones. Those overtones do a great deal to lend the instrument its characteristic sound quality, and so, cut-off frequency and instrumental timbre are closely linked.

We can look to sax and oboe again as the extreme examples. Saxophones have extremely large toneholes, and a correspondingly low cut-off frequency. The tone is weak in upper harmonics, with rarely anything higher than about the third harmonic significantly present in the tone -- even though the sax radiates lower pitches with extraordinary power. Oboes, with their very small toneholes and correspondingly high cut-off frequency, have a tone that is conspicuously full of high harmonics.

One of the conclusions we can derive from all this is as follows: It's a good idea not to have gross variations in size between your wind instrument's the toneholes. When hole sizes vary, you get very noticeable inconsistencies of volume and timbre from one note to the next. On well-made wood-

FIGURE 4: Undercutting the tonehole creates the effect of a larger hole without actually increasing aperture size.



winds, one finds that cut-off frequencies are fairly uniform from one tonehole to the next.

A few more notes about tonehole size and shape:

Toneholes with sharply cut, angular edges create turbulence in the air in their vicinity, which can affect timbre and willingness to speak. It's a good practice to round off tonehole edges.

The hardness or softness of whatever covers toneholes can have significant effects. Large areas covered by soft pads increase damping and have some effect on frequency, as mentioned above. Interestingly, these effects aren't all bad. Clarinet players sometimes conclude after having new pads installed that they preferred the mellower sound of the old, softer pads to the brighter sound of the harder new ones.

A common technique in making toneholes is to undercut them, so as to leave a smaller and more easily-covered opening at the top of an otherwise larger hole. The effect is similar to that of a larger hole, because it effectively reduces hole thickness. Undercutting can be used as a re-tuning technique on existing instruments, because it allows you to alter the pitch without affecting the manner in which the pad or finger fits over the hole. You can also use it in situations in which you need to enlarge further a hole that is already becoming too large to cover.

REGISTER HOLES

Many wind instruments can play over two or three registers, meaning that the same fingering can produce two or possibly three widely-spaced notes, depending on which of its possible modes the air in the tube is vibrating in. The player can play an ascending scale through the entire series of toneholes, then re-cover those holes, force the air into the tube into a higher mode of vibration, and continue the ascent through a second register while repeating the same series of tone holes, and then, with some instruments, repeat again still higher through a third register. This increases the instrument's range without requiring a whole new set of toneholes. Sometimes the key to forcing the instrument into a higher mode of vibration for a given fingering is all in the embouchure. Air flow angle, air pressure, lip pressure, and/or oral cavity size combine to ensure that the air is excited in one mode or another. But with more sophisticated instruments, the determination is made more sure and stable by the use of a register hole.

A register hole usually takes the form of a small hole rather closer to the mouthpiece than the far end, which remains open the entire time the instrument plays in the upper register. There may be one all-purpose register hole on an instrument, or two or three on a single instrument, designed for different registers or different portions of different registers. Or, as is the case with flutes and recorders, one another of the regular tone holes may double as a register hole.

Register holes work in a manner analogous to the string player's technique for isolating harmonics. The player lightly touches the string at a point which would be active in the unwanted lower mode of vibration, but is a node for the desired upper mode. This damps the lower mode while still allowing the upper to sing out. On winds, the register hole is located at a point of maximum pressure variation for the lower mode (the mode that the player wishes to inhibit in order to bring out a higher mode). When the hole is closed the lower mode is free to vibrate normally. But when the hole is open, it creates a leak just at the point where the the pressure build-up is essential to maintain the lower mode. The leak undermines any pressure build-up, and so inhibits the lower mode. Yet it has no such effect on any higher mode that happens to have a pressure node at that point – it remains free to sound. The trick, then, is to locate the register hole at a point that is a pressure variation maximum for the lower mode(s) you wish to eliminate, and a pressure variation minimum (a node) for the mode you want to bring out. Figure 5 below shows the ideal locations for a register hole designed to throw the instrument into the second register for the three most common basic tube types.

But notice that these locations are ideal for a tube with no other open tone holes. If you were to open toneholes along the tube, you would shorten the effective wavelength within, and in doing so move all the nodes and antinodes correspondingly farther up the tube. The register hole would then be

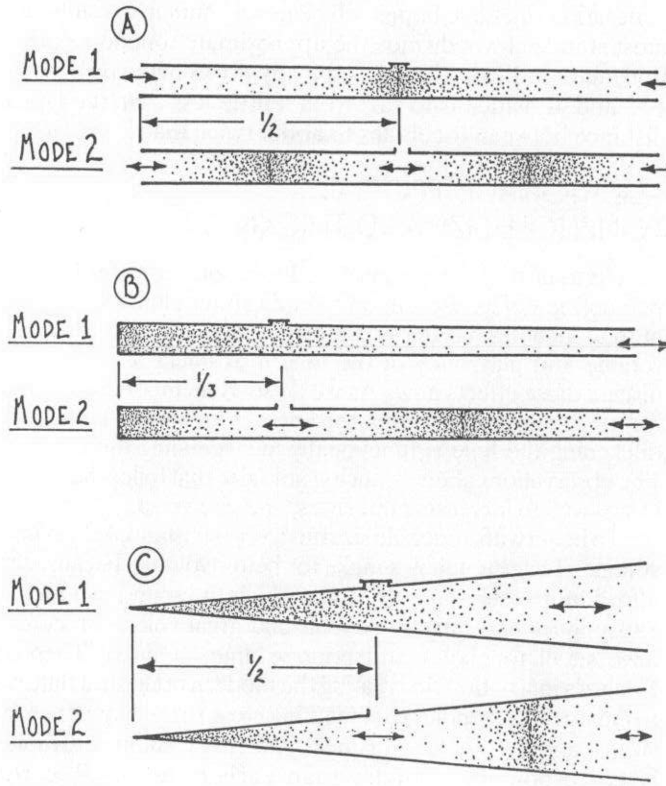


FIGURE 5: Register hole placement to bring out the second register in three basic tube types. Standing wave patterns for the first and second modes are shown for each tube type. Heavily stippled areas represent regions of maximum pressure variation; double-headed arrows within tubes represent areas of maximum movement and minimum pressure variation.

These placements apply when the tube's entire vibrating length is in effect. When toneholes are opened along the tube, register hole placement should reflect the shorter wavelengths that result, and so should be placed correspondingly closer to the mouthpiece. Since this seemingly would call for many different register hole placements (one for each open tonehole configuration), it's common to have one or more register holes placed in compromise positions somewhat closer to the mouthpiece than the whole-tube register hole placement shown here.

A: Cylindrical tube open at both ends. Ideal register hole placement is at 1/2 of the tube length.

B: Cylindrical tube stopped at one end. Ideal placement is 1/3 from the stopped end.

C: Conical tube. Ideal placement is at 1/2 of the tube length. Notice that the ideal register hole size for the conical tube is larger than the very small holes that serve best for cylindrical tubes.

misplaced. It seems to follow that we need a new, precisely-located register hole for every note of the lower register. That would indeed be ideal, but real-world musical instruments get by with much less. When the register hole is reasonably close, but not ideally located, it still has the effect of inhibiting the lower mode a good deal more than it inhibits the upper. Under those circumstances, the air column will be more inclined to set up a strong vibration in the upper mode than the lower. And so a compromise position for the register hole can usually be found which will be OK, though perhaps not great, over a substantial part of the range. Misplaced register holes cause a small amount of detuning, as the additional venting raises the pitch. That's part of the compromise. It so happens that the traditional design for oboes employs three well-located register holes (two octave keys and a half-hole), each one applying to a different part of the range. They work very well, dependably throwing the instrument into a stable upper register. Saxophones have two; they do reasonably well. Clarinets have but one, so it's not surprising that register control on clarinet is considerably more difficult to master.

The practical rule in locating register holes might be something like this: For the best compromise location, place the register hole near the ideal location (lower mode pressure antinode / upper mode pressure node) for some representative note near the middle of the range over which the register hole is to apply. This means moving the hole some modest distance up the tube (toward the mouthpiece) from the ideal whole-tube location suggested by the diagrams in Fig. 2 above. That puts it in a position to reasonably accommodate the shorter internal wavelengths when there are open toneholes. Register holes may function better when the effective thickness of the hole (t_e) is as small as possible. Register holes for cylindrical instruments should be quite small (typically less than an eighth of an inch); their ideal size is larger for conical instruments.

TONEHOLES FOR GLOBULAR FLUTES

Finally, we append to this theoretical part of the discussion some notes on globular flutes, which operate by a different set of rules than columnar vibrating systems. Globular air chambers oscillate as simple spring and mass systems. The speed of the oscillation does not depend upon the length of the air column (naturally, since there is no column) but upon the rate at which air moves in and out of the whatever opening the chamber happens to have in it. This rate depends upon 1) the size of the chamber and 2) the area and effective thickness of the openings. The simplest way to vary the pitch on such instruments, then, is through varying the opening size, and the simplest way to do that is through the use of toneholes. Each time you open a tonehole on a globular flute, you increase the cumulative available opening area, and the pitch rises accordingly. The size of the tonehole – that is, how much effective area it adds to available opening size – is all that matters. It makes very little difference where you place the holes. So the natural thing to do is to place them in the locations that will best accommodate the player's fingers. It's fairly easy to create well-tuned toneholes on an ocarina by educated guess and instinct, without recourse to mathematics. Simply start each hole at any location chosen for ease of fingering, making it small so as to produce a pitch below the desired pitch. Then enlarge slowly and carefully until the desired pitch is reached. The only potential complication is that the addition of more tone holes may marginally throw of the tuning of the previous ones by creating additional volume of air within the chamber due to closed tonehole cavities. If necessary you can go back and correct the previous toneholes by enlarging them a tiny bit more.

Globular chambers do not resonate overtones effectively, so for them the subject of register holes is irrelevant. You have no choice but to be content with the pitches you can coax from the fundamental register. This amounts to a rather limited range, normally extending over a musical 6th or 7th; the maximum seems to be about a tenth. If you try opening up more holes beyond this range, the thing becomes increasingly unwilling to speak. Figure 6 shows a standard ocarina fingering.

Part two of this article will appear in the next issue of **Experimental Musical Instruments**. It deals with the practical side of tonehole making and keying systems. See you then.

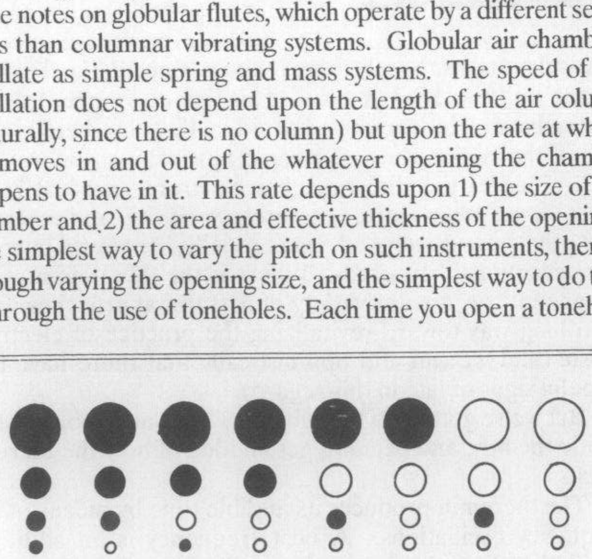
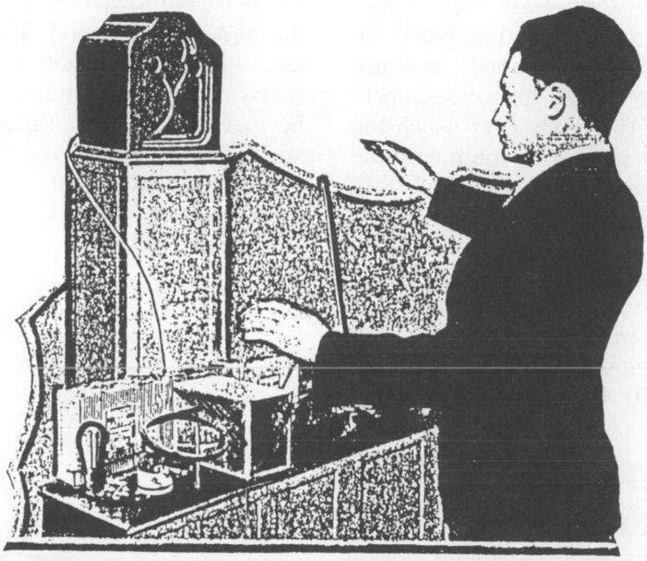


FIGURE 6: Typical four-hole ocarina fingering (blackened circles represent covered holes). With additional cross-fingerings not shown here you can obtain all the tones of a chromatic scale except the minor second and minor third. Notice that the holes become successively larger -- this is to achieve a suitable percentage increase in total open area with each new hole. (Hole sizes not drawn to scale).

STILL NOTHING ELSE LIKE IT: THE THEREMIN

by Ivor Darreg and Bart Hopkin

In 1920, the Russian physicist Leo Thèremin was engaged in designing an electronic burglar alarm, in an early practical application of electrical technology. Thèremin's alarm was designed to respond to changes in electrical capacitance caused by the approach of a foreign body, by producing a whistle over a remote set of headphones. In the course of this work, Thèremin became intrigued with a particular property of the device that he had created: the pitch of the whistle, he noted, changed in a predictable way with the proximity of the approaching body. Holding his hand in the air before the alarm and varying his hand's distance by discrete amounts, Thèremin found that he could play recognizable melodies, audible over the headset.



From this observation evolved Professor Thèremin's extraordinary musical instrument, now usually called in English the theremin. The theremin was completely unique when it began to be popularized around 1928, and it remains unique today. It is the only musical instrument, before or since, played without being touched. It is the only musical instrument, before or since, with not a single moving part (on a macroscopic level) save the speaker diaphragm that moves the air. For those not already familiar with it, a brief description:

In its standard form, the theremin consists of a box containing electronic parts. From this box rise two antennae. One is usually an upright rod; the other often a looped antenna. A wire from the box leads to a separate amplifier and loudspeaker. The player, standing before the two antennae, holds one hand in proximity to the upright antenna, and the other in proximity to the loop. The loop controls the volume. The closer the hand is to the loop, the louder will be the tone. Pull the hand far enough away and the sound stops entirely; gradually bring it closer and a swell or crescendo will be heard. The upright antenna controls the sounding pitch. The closer the hand, the higher the pitch (this need not be so, but it is the standard arrangement). Holding the hand farther away and slowly moving it closer produces a continuous ascending glissando. The instrument thus has a natural affinity for extreme portamento, and much of the art of playing consists in learning to move the hand quickly and smartly to the right position for the desired pitch. There is no anchor or reference point to help one find the spot; only the expanse of space. The tone quality may vary from one instrument to the next, but generally is close to a simple sine wave tone. Considering both tone quality and the affinity for portamento, the sound is often compared to that of the musical saw.

As one might imagine, this playing technique was considered most extraordinary when theremins first appeared in the late twenties. The idea of performing on a musical instrument merely by waving one's hands in front of it was the sheerest magic! And even today, while people inevitably have become casual about technologies for remote cause and effect, the playing of the theremin retains a strange, supernatural quality – and a certain poetic aspect as well. Readers of **Experimental Musical Instruments** might often have paused to think about the importance of physical gesture in the personalities of musical instruments – the characteristic playing movements for different instrument types, and the ways in which those movements translate into characteristic sounds and musical patterns. Surely there is no instrument like the theremin in this matter of gesture. This line of thought takes on particular weight when one considers that the theremin was one of the very earliest electronic musical instruments, and then observes the direction that electronic musical instruments have taken since: the great majority, and especially those that have dominated commercially, are played by means of conventional keyboards. Where is the theremin now that we need it? A greater variety of gestural approaches would go a long way toward revitalizing the practice of electronic music (and we can add optimistically that there have been hopeful signs of late in this regard).

But we've gotten off the subject. Let us now look at what's inside the box, and begin to get an idea of how the theremin works.

The theremin produces its audible tone by means of beat frequency oscillations. A beat frequency is an additional oscillation that arises when two oscillations of similar but not identical frequency are combined in the same medium. This comes about because, given two oscillations with one slightly faster than the other, the two will periodically move in and out of phase with one another. If, for instance, they start out in phase, with their points of maximum positive displacement coinciding, then as they proceed to vibrate the faster gradually

Center page graphic: Drawing from an article called "Musical Tones from a Beat-Note Audio Oscillator", giving instructions for making a home-made theremin, from **Radio News** magazine, June, 1930.

gains on the other, until its point of maximum positive displacement coincides with the other's point of maximum negative displacement. The two are then at cross purposes, and the sum of their vibrations is weaker as they at least partially cancel one another. As more time passes, the faster oscillation continues to gain and eventually reaches the point where its maximum once again matches the other's maximum; they now once again reinforce one another for a stronger cumulative vibration. As the process continues, the result is a regular periodic variation in the amplitude of the combined vibration. This secondary, slower oscillation is the beat frequency. Musicians will recognize the phenomenon as a familiar one. When the oscillations in question happen to be sound vibrations, the beat frequency will be heard as in one of two ways: if its own frequency happens to fall in the hearing range, it will be audible as a difference tone – a third, lower pitch sounding along with its two progenitors. If its frequency happens to be below the hearing range, it will manifest as "beating" between the two original pitches – an audible wavering in overall volume as the two move in and out of phase.

It is important to note that beat frequencies take more forms than the one described here. This first-order difference tone is usually the most prominent, however, and it is the important one for the current discussion. A few moments' study will reveal that the frequency of beating will be the difference between the frequencies of the two parent tones.

The tone of the theremin is the difference tone arising from parent tones which are themselves set well above the hearing range. The oscillations originally take the form of alternating current in a circuit, which can then be amplified and sent to a loudspeaker. The parent tones are generated by radio frequency oscillators, with frequencies which might be anywhere from 50 kHz (50,000 cycles per second) to 500 kHz or higher. The two tones can be tuned to match one another initially, thus producing no difference tone. In performance, one tone does not vary. The other, under the player's control, does. As it does, the difference tone appears in the audible range; its pitch corresponds to the degree of detuning of the radio frequency tones.

How does this tuning and detuning work? The answer has to do with electrical capacitance. Capacitors and capacitance are discussed in the side bar at the end of this article. For those already familiar with these things, and likewise for those not wishing to get into them, suffice it to say here that changes in capacitance can be used to alter the frequency of an oscillating circuit. One of the high frequency oscillating circuits in the theremin has a variable capacitor built into it, allowing the circuit to be tuned by means of a knob or something similar. It is used to tune the two high frequency oscillators to match one another, so as to initially produce no beating and provide a silent starting point for the actual playing. Once this zero point is set, the frequency of this oscillator circuit remains stable during playing. The playing then consists in detuning the other oscillating circuit in a controlled fashion to create the beat frequency at the desired pitches. The player does this, you'll recall, by holding a hand near an antenna. So how does that affect the tuning of the circuit?

The human body possesses electrical capacitance just as the circuits of the theremin do. The forces involved in capacitance, being electrostatic in nature, can operate at a distance. The hand and the antenna, held in proximity to one another, affect one another's capacitance. They thus together form in effect another variable capacitor, this one controlled not by a knob, but by altering the distance between hand and antenna. The antenna is attached to one of the oscillating

ELECTRICAL OSCILLATORS AND CAPACITORS

At the heart of the theremin are high two high frequency electrical oscillators. The process of varying their frequencies relative to one another is the key to the instrument's operation. The high frequency electrical oscillators used in theremins (as well as other applications) take advantage of the natural resonant frequency of a wire. This is the frequency at which electrons in a wire of finite length will move back and forth, alternately piling up at one end of the wire and then, responding to the resulting electrical potential difference, bouncing back toward the other in a manner analogous to any other vibrating spring system. The oscillation is initiated and perpetuated when voltage is applied across the wire. The resonant frequency is determined by a variety of factors, and it is possible to introduce devices into the system which will allow the frequency to be easily adjusted. One such device is a variable capacitor. Briefly stated, capacitance is the ability of an object to hold and subsequently release electrical charge. In standard form a capacitor consists of two metal plates facing one another, with insulating material or air space in between. A wire loops around from one plate to the other; the capacitor can thus be seen as creating a break in what otherwise would be an unbroken circuit. The two plates can be thought of as small repositories for electrons as they rush back and forth. Naturally, when one plate acquires a surplus of electrons and becomes negatively charged, the other has a shortage and thus is positively charged. The result is an electrostatic force between the two which increases the amount of charge each plate can hold. This capacitance in each plate allows greater range of movement for the electrons at any given voltage, as compared to what it would be without the electrostatic forces resulting from the plates' proximity to one another. In an effect roughly analogous to reducing tension on a vibrating string, this has the effect of lowering the resonant frequency.

Varying the capacitance thus effectively tunes the circuit. It can be done by simple mechanical means, such as altering the distance between the plates, or altering the surface area that the two plates have directly opposite one another by "sliding" them past one another to varying degrees. As described in the main text, one of the high frequency oscillator circuits in the theremin has this sort of adjustable capacitor in it. It is used to tune the two high frequency oscillators to match one another, providing a reference point with no beating.

The frequency of the other oscillator is then varied, by means of another variable capacitor, to produce the beat frequency during playing. This other capacitor, quite different in form but similar in principle, uses the player's hand in place of one of the capacitor plates, and the pitch control antenna, which is connected to the oscillator circuit, in place of the other. The hand naturally possesses some capacitance of its own, since a surplus of electrons can accumulate in or retreat from it in response to its electrostatic environment. As in the standard capacitor described above, the proximity of the two parts to one another brings electromagnetic forces into play which increase the the ability of each to hold a charge, even without physical contact.

Hand capacitances are miniscule, and of themselves not sufficient to detune the circuit enough to provide an adequate musical range. (For typical parent frequencies in the vicinity of 150 kHz, detunings between a couple hundredths of a percent and something over one percent would cover the most of the musical range. Hand capacitance alone can achieve only the very bottom part of this range.) To alleviate this problem, between the antenna and the main oscillating circuit must be added additional circuitry designed to augment the effect of the hand capacitance.

In this article we'll stop short of describing this circuitry. We have likewise stopped short of describing the theremin's volume control circuitry. This information is available from some of the sources listed in the bibliography.

circuits of the theremin, so that changes in its capacitance affect the tuning of its circuit.

And so it is that the peculiar act of waving one's hand before the antenna causes changes in the antenna's capacitance, which cause changes in the resonant frequency of one of the radio frequency oscillators, whose output when combined with the output of the other radio frequency oscillator produces a controllably variable lower beat frequency, which, through the good graces of an amplifier and loudspeaker, comes to us as series of musical tones.

The actual effect of hand capacitance alone on the circuit is tiny – not enough to cause sufficient detuning to generate beat frequencies high enough to be heard. So additional circuitry must be added to augment the effect (there's more on this in the side bar). The degree of augmentation can be made adjustable, and this adjustment very much affects the playing of the instrument. On one hand, the player might choose a large multiplier effect, so that relatively small hand movements produce an exaggerated effect on resulting pitch. The advantage of this is the resulting capacity to play over a very large range. But it then takes a skilled player to stay in tune, since any slight inaccuracy in hand placement has magnified pitch consequences. Some players, taking this approach, have claimed an eight octave range. At the opposite extreme, one can opt for relatively large hand movements, less exacting hand placement requirements for acceptable pitch, and a correspondingly limited range. This might be a sensible approach for beginners.

In a similar vein, one might wonder where to place the hand relative to the pitch antenna while tuning the parent oscillators for the no-beating point. Entirely out of range? A better approach might be to adjust it so that the tone zeros out when the right hand is at its farthest back comfortable location. Then as the hand moves closer, the lowest audible pitch quickly comes into play, and pitch continues to rise from there. A less favored alternative might be to set the zero point for the closest hand position, so that pitch rises as one moves away (remember that the pitch of the beat frequency corresponds to the difference between the two parent frequencies; it matters not whether that difference results from rising or falling in the variable parent frequency). One could even, just for the fun of it, set zero at some middle point and allow the pitch to rise on either side.

The two parent oscillator circuits must be shielded from one another in their casing, or they will tend to pull in tune with each other whenever their frequencies are close. This can result in the loss of the instrument's lower range. They also must be shielded from possible external radio frequency sources, since the audio-range results of such interference are at best unpredictable. Anyone intending to play multiple theremins in ensemble should also think about shielding one from another, or else set the zero-point parent oscillations of each to widely-spaced frequencies so that if interference between them does occur, it's less likely to create audio-range beating.

The volume on traditional theremins is also controlled by means of hand capacitance, using an external antenna (the looped antenna, in the conventional configuration) connected to circuitry within the casing. Several circuits can be used to control an amplifier by means of controlled variable capacitance. We won't go into full descriptions here. More prosaic means for volume control have also occasionally been used with theremins and other theremin-like instruments, such as manual controls, foot pedals and the like.

An interesting question for theremins is that of timbre. Theremin tone is usually fairly antiseptic – not much in the way of either harmonic overtones or non-harmonic noise. Robert Moog (whose role in later theremin history is discussed elsewhere in this article) has suggested ways to generate a livelier spectrum in theremin tone. He observes that if the shielding between the two oscillators is less than perfect (but not so poor as to allow the two to pull together *too* easily), then the oscillators may, by "dragging" on one another, pull themselves into harmonically-rich sawtooth wave forms. The harmonics in the parent oscillations will manifest themselves correspondingly in the audio-range beat frequency.

On the other hand, even if the theremin's output is a basic sine-tone, with the range of signal processing circuits available to electronic musicians today, a great deal can be done after its initial generation to embellish it. Theremin's own earliest instruments apparently did not use any timbral modification, beyond the distortion that early electronic amplifiers might have added.

HISTORY

At this point, let us take a few steps back to fill in some background and review the instrument's social history.

First, names. The theremin's inventor's family name was originally French, sometimes given as Thérémin. This was later accommodated to the Russian language of his birth, and the Russified version is sometimes rendered in English as T'ermin or Termen. His first name appears in different documents variously as Lev, Leo and Lèon. In this paper we have taken as authoritative the name that the man himself affixed to his U.S. patent application, Leo Ssergejewitsch Thèremin. His instrument, too, has gone under several names, including *thereminvox, terminvox, aetherophone* or *etherphone*, and *thereminophone*. Professor Theremin himself usually called it simply the vox. In this paper we have stuck with the name that has gained widest usage in English, the admirably plain, unaccented *theremin*.

Leo Thèremin was born in St. Petersburg in 1896. He studied physics (and cello) at Petrograd University, and after the revolution set up a research lab at the Physico-Technical Institute in Petrograd. It was there that he undertook to create the fateful burglar alarm around 1920. He was giving public performances on the new instrument by 1921, toured the capitals of Europe as his reputation grew, and in 1927 came to New York. He remained in the United States until 1938. After the Second World War he returned to the Soviet Union, eventually to become a professor of acoustics at Moscow University. Beyond this, essentially nothing of his activities in the fifty years since his return had been known in the West – in fact, at the time this article was in its early drafts we were unable even to ascertain whether he had died, or was, against all odds, still around. But the world changes; the walls come down; what was hidden is revealed, and, lo, here is Leo Thèremin, at age 95, playing the Theremin at the *Bourges International Festival of Electronic Music* in Bourges France, in 1989. His playing there, and that of his daughter, who also performed, was such that anyone who had previously thought of the

Drawing from a promotional flyer for the Melodia model theremin produced by R.A. Moog Company. The melodia took the form of a narrow box with a single antenna for pitch control; volume was controlled by a knob on the front of the casing.

theremin as a novelty or a toy would have come away with a sense of the instrument's subtlety and beauty – this according to a review in **Computer Music Journal**, Fall 1991. In the time since, there has been a surge of interest and several articles on the man and the instrument have appeared.

Thèremin's original appearance in the U.S. in 1927 and his ensuing public performances likewise generated a surge of interest. He received U.S. patent 1,661,058 in February 1928 (following an earlier German patent). RCA soon obtained rights and began manufacturing theremins around 1929. It was costly, the price reportedly exceeding $500 in those-days-dollars. RCA's early models were big, weighing over 80 pounds, and had a reputation for being capricious and unstable in performance. The depression soon put an end to RCA's theremin production. It's not clear how many theremins were commercially manufactured at that time. I have seen widely disparate numbers. The higher figures (from Anfilov – see the bibliography) suggest that three companies made over 3,000 theremins and closely related instruments during that early wave of popularity, and that 700 professional thereminists were at one time registered with musicians trade unions.

For a period of years after the depression theremins were not commercially manufactured. Then, in 1954, commercial production resumed under the hands of a then-obscure nobody named Robert Moog, with his R.A. Moog Co. By the 1960s Moog was making five models of theremins, claiming a number of improvements over earlier designs.

Although the theremin has retreated somewhat from the mainstream music scene, it did in its day have some impact. Between the mid- twenties and the mid-forties, a number of respected composers (Varese, Grainger and others) wrote orchestral works featuring theremin; some were debuted with important orchestras and under famous conductors. Leading players were Lucy Bigelow Rosen, Mrs. Clara Rockmore and Dr. Samuel Hoffman. A couple of theremin ensembles surfaced in New York in the early thirties, featuring 15 or 16 players. Theremin took the place of musical saw in some show bands and novelty bands. To its detriment, it has often been associated in TV and film scores with science fiction, serving, for instance, as the lead instrument in the signature theme for the early '60s TV show, "My Favorite Martian." A bit more recently the California suburban pop group The Beach Boys used theremin quite prominently – to rather irritating effect, unfortunately – in their very popular song "Good Vibrations."

The physical principle underlying the theremin was always too good to be limited to a single instrumental incarnation. Over the years the theremin has spun off any number of derivative instruments, including some cheap imitations, some valid variations and some important improvements. For that matter, the theremin itself evolved over the years. It started out, before the invention of the loudspeaker, audible only through headphones. Leo Thèremin soon devised a large "earphone" which incorporated a cardboard horn like those used in early phonographs, before finally turning to the loudspeaker. Thèremin devised a number of other variations and improvements on his own instruments as time went by. In the years leading up to 1930 he perfected a monophonic keyboard version of the instrument, as well as one with a cello-like cylindrical fingerboard controller. A couple of years later he came up with his Keyboard Electric Timpani, again based on the same electrical principles. Around the same time he created his

NOTES FROM IVOR ON THEREMIN MAKING

A "radio ham" or experienced repairman might be able to take two old radios and disconnect what was irrelevant and let a signal from the oscillator of one set get into the converter stage of the other, making a crude theremin to have fun with. Not sure whether kits or little packaged BFOs (beat-frequency oscillators for code reception) are still available, but if they are, two of them could be connected to a diode network and a volume pedal and then that plugged into your small amplifier. One BFO would have to have an antenna connected to it. This also might work for building one's own experimental ondes Martenot.

Computer parts are not suitable because they are digital. The theremin is the most analog of electronic instruments. Therefore people who have worked only with digital equipment will not understand how to make a theremin unless and until they study analog devices. Don't even think of applying the MIDI system to a theremin; that would be impugning its basic nature. I've had horrible arguments with digital technicians! They get MAD when I point out that "digital theremin" is the prize oxymoron of the century.

My experience with the theremin: back around 1927 or 1928, I heard it on the radio, and half the time did not know quite what it was. Then I saw an early **Radio News** magazine [an early popular electronics magazine, now defunct] at the newsstand with a picture of an ensemble of theremins on the front cover. Alas! pure imagination, it never was permitted to happen, one more reason why I hate the Musical Establishment TO PIECES. Also why they hated me back. The insults and scorn from my music teachers shouldn't happen to a dog.

In 1936-7-8 I got theremin music out of radio sets. About 1947 I built a theremin that had both oboe and flute timbres. About 1951 I modified it and put it in a better looking box. In the sixties, more modifications with later type tubes and parts. Right now, after growing interest on the part of the majority of visitors here, I will repair and refurbish the theremin here, and advise more visitors who seem to be quite interested in the instrument.

– Ivor Darreg

Terpsitone, or "Theremin Ether Wave Musical Stage." It was in effect a theremin made on a larger scale, designed to respond to a dancer's full body movements – a wonderful idea. (Moog also created something like this for a John Cage dance piece in 1965.) Some of Thèremin's unrelated projects were equally interesting, though less germane to the current article. The Rhythmicon was an electro-mechanical, keyboard-controlled rhythm machine built at the request of Henry Cowell. It used rotating disks to interrupt light falling on a photoelectric cell to produce precise temporal subdivisions; each subdivision was realized as one tone in a harmonic series. Thèremin also experimented with apparatus for color music and tactile composition.

Theremin-like instruments by other builders include the sfaerofon, the ethonium, the electronde, the electronische zaubergeige, trautonium and croix sonore (this last being most impressive looking, employing a large cross mounted on a sphere). Most important is perhaps the ondes Martenot, created by Maurice around 1928. In Europe, ondes Martenot has to some extent eclipsed the theremin in the long run, enjoying greater prestige and popularity. See Thomas Bloch's article in EMI Volume VIII #1, September 1991, for more on the ondes.

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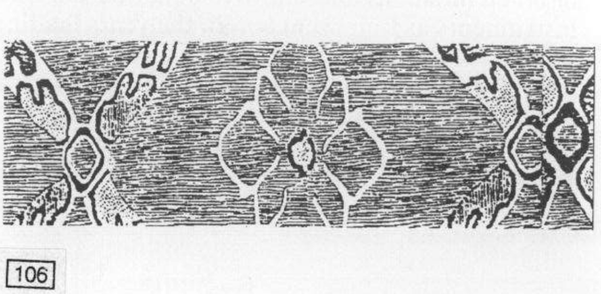


A SIMPLE THEREMIN FROM SCHEMATIC TO PERFORMANCE

by Bonnie McNairn with James Wilson: Voice of Eye

The theremin schematic described here and appearing on the following page is reprinted with permission from **Hands-on Electronics** Magazine, September 1987 issue.

Last winter Phil Krieg, a fellow Houston noisician, gave us a copy of the theremin schematic which accompanies this article. This design employs a two-chip digital circuit powered by a 9-volt battery. It would be a good project for a beginner in electronics, as it is very simple to build, small and relatively inexpensive (we paid approximately $10 for parts).

This theremin varies in pitch only, not in volume. The sound of this instrument is thin and a bit noisy, similar to short-wave radio. However, when used in conjunction with even simple effects units such as reverb and distortion, its voice can grow large and menacing, or smooth and oceanic.

Phil houses his theremins compactly in an 35mm film canister. Our circuits are housed in small peanut cans, and use a 10K trim pot with a knob (not the screwdriver kind) to adjust the sensitivity. Substitute 47pF capacitors for C1 and C2 if 51pF can not be found. For the antenna, any conducting material will suffice. Examples include metal, shielded/unshielded cable, or water.

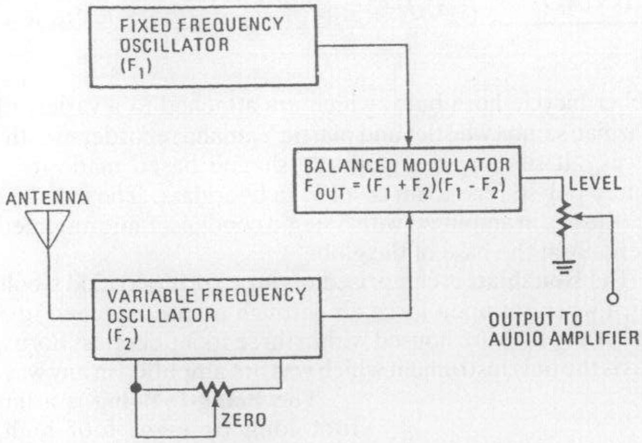
The antenna we use is a 1' x 4' piece of sheet metal, spring mounted upright on a wooden stand. We chose this antenna to create a surface physically large enough to be visually and spatially confrontational to the player's body. We plan to use a 4' x 8' piece of sheet metal in performance during the October '92 NAAO conference in Austin, Texas.

We took two theremins with us during our summer '92 tour. After a performance for a small gathering in Port Townsend, Washington, the audience (ages 7 to 45 years) took turns playing the theremin. One by one, each person created a different character, moving their bodies to vary the capacitance. Their movement was being transduced into the audio version of the character. One woman stood motionless just at the threshold of the sound, mentally projecting her energy field.

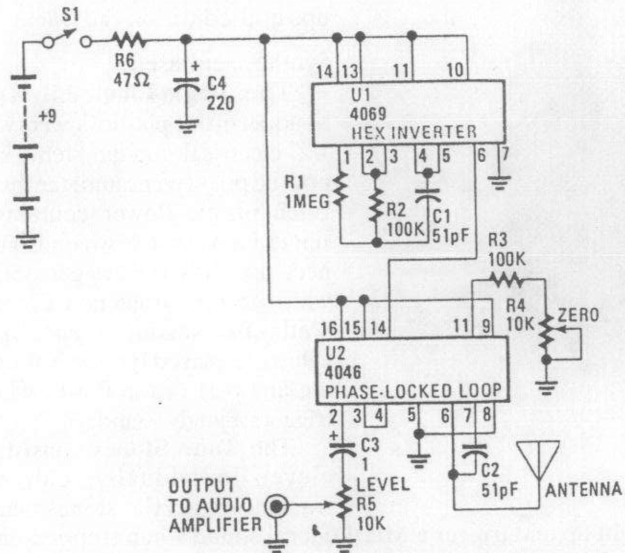
The phenomenon of expressing sound through the movement of our bioelectrical pulses is just scratching the surface of an invisible world as it becomes tangible to us. The theremin is an instrument that unveils to us our own electrical charge, and encourages us to explore our less apparent attributes.

For help in reading schematics and a general description of electronic components, I recommend *How to Read Schematics*, by Donald E. Herrington (Howard W. Sams & Co., Inc., 1986). Most intro-level textbooks found in your local library are also good references. However, the best information resource is a real-live human with prior experience. Here's a hint: befriend the people in your local electronics parts store.

Bonnie McNairn and Jim Wilson make up the duo Voice of Eye, *performing with a variety of unconventional instruments and sound sources. Their newly-released CD* **Mariner Sonique** *is available from Cyclotron Industries, P.O. Box 66291, Houston, TX 77266. Contact Bonnie and Jim through Cyclotron Industries.*



THE BLOCK DIAGRAM FOR THE DIGITAL THEREMIN (above) shows a pair of high-frequency oscillators – one oscillating at a fixed frequency, and the other variable via body capacitance. The outputs of the oscillators are mixed by a balanced modulator circuit, which suppresses the original inputs to produce a complex derivative, consisting of the sum and difference frequencies.



CIRCUIT NOTES

The CD4069 or 74C04 hex inverter is used as a fixed frequency oscillator centered around 100kHz. U2 contains the variable frequency oscillator and balanced modulator. The CD4046 is a phase-locked loop and R3, R4, and C2 determine the center frequency of the on-chip oscillator. The antenna forms a parallel capacitance with C2, which allows the frequency to be shifted several kilohertz by bringing a hand near the antenna. R4, the ZERO control, allows the variable oscillator to be set to the same frequency as the fixed oscillator. When the difference frequency is below 15Hz, it is below the lower frequency limit of the ear. By setting both oscillators to the same frequency, the Theremin remains silent until the performer brings his or her hand near the antenna. The oscillators are mixed by an exclusive OR gate inside the 4046. That gate acts as a digital balanced modulator, which produces the sum and difference frequencies. The output of the gate is then ac coupled by C3 to LEVEL control R5 and an output jack for connection to an audio amplifier or stereo receiver.

NOTICES

•THE TUNING OF THE WORLD, the First International Conference on Acoustic Ecology, will take place August 8 - 14, 1993 at the Banff Centre for the Arts. For information write the Conference Registrar, The Tuning of the World, Banff Centre for the Arts, Box 1020, Stn. 28, 107 Tunnel Mountain Drive, Banff, Alberta, Canada, T0L 0C0.

Just Intonation Calculator, by Robert Rich and Carter Scholtz. A composer's tool for just intonation. Internal sound for tuning reference; microtonal ear training; shows modulations; reduces fractions; converts between ratios, cents and Yamaha tuning units; MIDI tuning dumps for many brands of synths, and supports MIDI tuning dump standard; includes dozens of tunings. Requires MacIntosh and Hypercard. Only $10.00. Soundscape Productions, Box 8891, Stanford, CA 94309.

MUSIC AND MIRACLES: Don Campbell's new anthology on the future of music and transformation. Kitarro, Larry Dossey, M.D., Lorin Hollander, and David Darling join two dozen other outstanding music therapists, doctors and theologians for stories, theories and emerging possibilities. $15 + $3 P&H from I.M.H.E. PO Box 1244, Boulder, CO 80306.

The 4th Annual Invented Instruments Festival takes place in Chicago April 24, 1993. In conjunction with the festival, Chicago's Experimental Sound Studio sponsors the "Instrument Invention & Sound Exploration" workshop (directed by Hal Rammel) in 4 Saturday afternoon sessions preceding the concert. For further information contact the Experimental Sound Studio at (312) 784-0449.

MICROTONE GUIDE. 34 page booklet of microtunings for synthesizers or new instruments. Ethnic, historic, just, & equal tunings. Good sourcebook for beginning microtonalists. $7.50 to C. Fortuna, 1305 Hartrick, Royal Oak, MI. 48067

The UWM Art Museum (3253 N Downer Ave., Milwaukee, WI) presents "an evening of live performances on new and old sound inventions" by Hal Rammel, Feb 12 at 7 PM. For information call the museum at (414)229-6243.

IBM CLONE FREEWARE for JUST INTONATION. Freestanding program calculates just modulations/demodulations/intertones/complements, as well as string positions and ratio to cents. Menu driven, includes source code. Send formatted disk 51/4 or 3.5 inch, one dollar return postage (suggested) or trade material. NOVOSONICS, RFD 1 Box 312, Contoocook, NH 03329.

Amos! One Kate, who lives in Ipoh, has drowned logos! Fool, snot not at a ton – tons, lo! – of so golden words: Ah, hopin' is evil. Oh, we take no soma. -- Ancient palindrome.

QUARTZ CRYSTAL "SINGING" BOWLS", frosted and clear in 12 sizes, in all musical notes available – magical – powerful healing tools for meditation and stress elimination, balancing energies, etc. Also available: handheld square drums, hoop and dance drums as well as water and ceramic kettle drums, various types of RAINSTICKS, melodious chimes, bells, cymbales. Largest distributor, lowest prices. The CRYSTAL STORE 1-800-833-2328.

MICROTONAL MIDI TERMINAL (vers. 1.2) by Denny Genovese lets you play nearly any MIDI synthesizer in Just Intonation! A veritable "tuning processor" as well, it has many features for constructing, editing, transposing, analyzing and printing Just Scales. Tuning data is shown in Ratios, Cents, Frequencies and Yamaha TU's. Those without a MIDI instrument can hear the Just scales on the computer's built in speaker. Holds 16 scales in memory, which are selected by single keystrokes. Tunings may be transposed into any key with another quick stroke. Requires IBM XT/AT or compatible and, for performance, an MPU-401 or compatible MIDI interface. $60 from DENNYS SOUND & LIGHT PO Box 12231 Sarasota, FL 34278.

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CASSETTE TAPES FROM EMI: $8 per cassette for subscribers; $10.50 for non-subscribers. Prices include postage for U.S., Canada, Mexico air, and overseas surface rate. For overseas air add $20%. Each tape contains music of instruments that appeared in the newsletter during the corresponding volume year, comprising a full measure of odd, provocative, funny and beautiful music. Volumes II, III, VI and VII remain available; volumes I, IV and V are now sold out. Order from EMI, Box 784, Nicasio, CA 94946.

THE MUSIC ATRIUM
A Musical Playground for Kids

by Dean Friedman

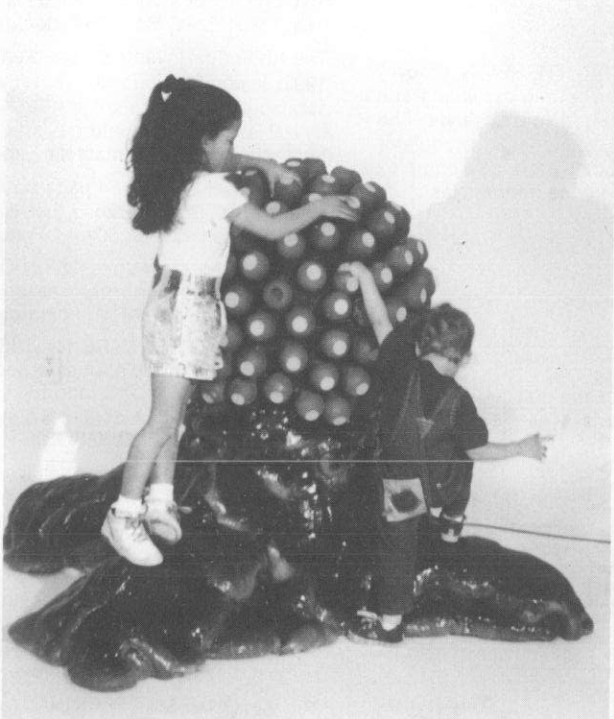
In the Fall of '91, while hammering out details for the production of an interactive video installation at the *Eureka!* Children's Museum in Halifax, England, Richard Fowler, director of exhibits at the museum, mentioned to me that they had still not finalized a design for their proposed "sound area".

My ears instantly perked up. While I spend a good amount of time these days designing virtual reality game environments and creating interactive video installations, my background is in the music business, (I had a few hit records, "Ariel," "Lucky Stars," in the late '70s, and wrote the first consumer guide on music synthesizers.) and the thought of developing a music exhibit was extremely appealing.

DESIGN

My motivating design concern was the strong feeling that too many sound and music areas in children's museums relied on conventional instruments such as keyboards, guitars and drums.

I felt that traditional instruments, which can be difficult to play unless you have been musically trained, were very often intimidating to children, and that as a result, their frustration level would run extremely high. Kids not knowing how to play conventional instruments would grow quickly disappointed at their inability to produce musical sound and the negative experience might reinforce whatever lack of confidence they might have about their own music making abilities.



The Booble

Therefore my goal was to create a class of musical instruments specifically designed to be fun and easy to play, to be inviting and appealing to kids and to be capable of producing pleasing and musical sounds when played by children, and adults, with or without a music background.

My main curriculum goal was not to examine the physics of acoustics and sound generation, but to teach children, what I consider to be, the most important musical lesson of all – that making music can be fun.

These ideas led to the design of the following 6 instruments, three of which are acoustic and three of which are synthesizer based. Brief descriptions follow:

Acoustic –

The **Booble** is a three foot diameter globe covered in rubber bicycle horn bulbs which are attached to a variety of Brazilian samba whistles and plastic Yamaha recorder mouthpieces. It sits on an organically shaped based made from poured polystyrene foam covered in fiberglass. The sound of the whistles in amplified with a single condenser mic mounted internally at the base of the globe.

The **Honkblatt** is comprised of three spring-loaded stools which when sat upon force air through a hose attached to 3 fog horns which are housed within three foot fiberglass horns. This is the only instrument which was not amplified in any way.

The **Boing-D-Boing** is a ten foot long by eight foot high, sculpted, misshapen guitar of sorts, made of multiple layers of plywood and strung with twenty-six acoustic guitar strings and three nylon strings made from nylon weed-wacker stock. It is played with giant six inch plastic plectrums. Its sound is amplified by twelve DiMarzio guitar pick-ups housed within the frame.

Synthesizer based –

The **Jingle-Lingle-Lily** is a bouquet of five plastic flowers with 1/2" electrical conduit stems in a poured polystyrene and steel base. Each plastic flower contains a singlé Piezo switch which is connected to a MIDI trigger device which in turn triggers a Proteus synthesizer sound module. The Lilies are played by simply touching any part of the flower which triggers a jingly sound.

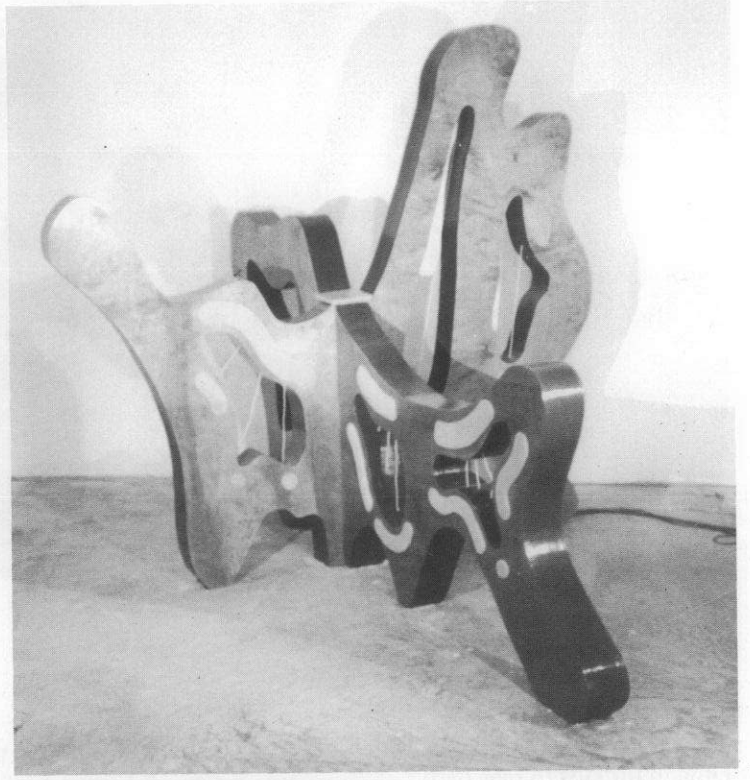
The **Tone Stones** consist of eleven individually sculpted, translucent acrylic stones which light up and trigger a MIDI choral sound when stepped on.

The **Laserharp** is a metal and fiberglass framed harp-like instrument which is played by strumming beams of laser light instead of real strings. Interrupting the beams of green light triggers a MIDI note event of a sample harp sound.

FABRICATION

Booble Parts

Parts and materials were the first production challenge. I spent two weeks trying to locate bicycle horn bulbs for the Booble of the appropriate size and color. In fact, what we wound up using were found in a hobby craft store being sold as fuel suction bulbs for model airplanes. Another two weeks was spent locating suitable whistles and sound devices. My favorite were Brazilian samba Nambu whistles which I found at Alex Music on 48th St. in New York City. These wooden whistles have a lovely mid-range tone and are easily triggered, without overblowing, when played by squeezing an attached rubber bulb. However, they were virtually impossible to get in large numbers. I picked up several sets on 48th St. and only

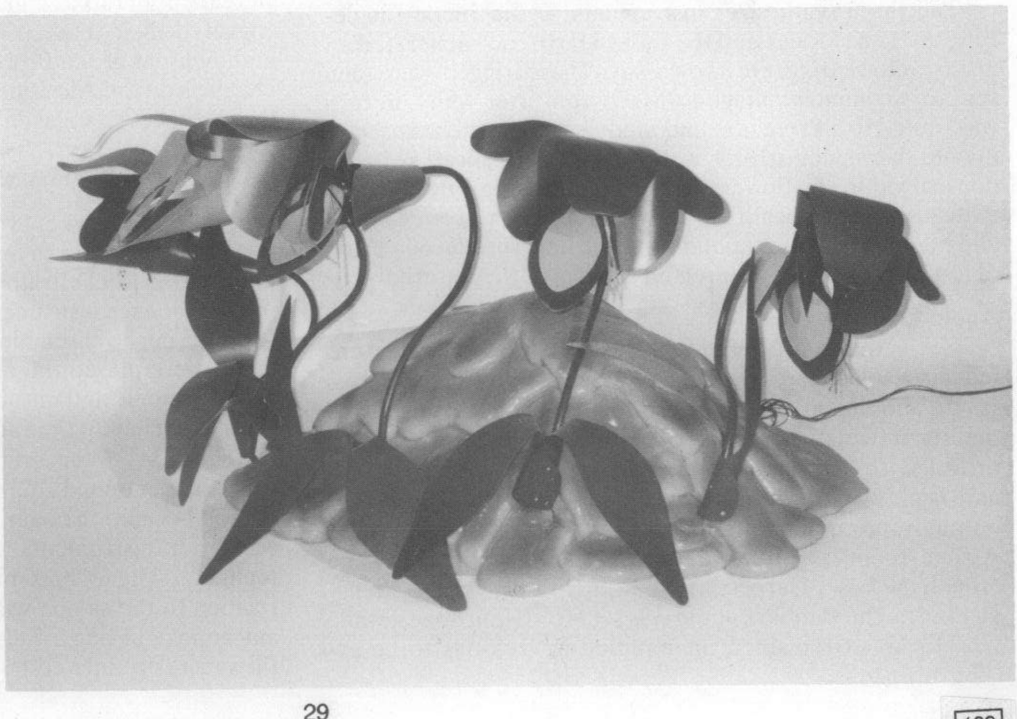


after dozens of phone calls was I able to track down a supply of thirty at the Woodstock, NY based "Anyone Can Whistle" musical instrument supply company.

I still needed another 120 whistles to cover the Booble surface, however, which forced me to use Yamaha recorder mouthpieces, cut to size and plugged at the end. Their sound was less pleasing than the Nambu whistles and for some reason they were more prone to overblowing; however they served the purpose and the resulting Booble has proven to be a big hit with everyone that plays it.

Laser Harp Safety

Technologically, the biggest challenge was configuring the Laser Harp so that it was not only functional, but also safe for kids to play. No existing laser exhibit, that I'm aware of, in any museum in the world, allows people, especially children, direct access to a potentially dangerous laser beam. My design, however, required that kids be able to touch the beam directly with their bare hands. Achieving this critical design criteria required weeks of research into FDA laser-safety regulations, power thresholds and class definitions before



Photos this page –

Above left:
The Honkblatt (partially hidden behind the Bloobble)

Above right:
The Boing-D-Boing

Right:
The Jingle-Lingle-Lily

Above: The Tone Stones.   Right: The Laser Harp

arriving at a formula under which the beams would be safe enough for kids to play with.

We opted to use a green Helium Neon laser just under two milliwatts and eight beam splitters and a mirror - for a total of nine "strings". The Laser Harp frame was fabricated out of steel covered in fiberglass. The beam area was encased in transparent plexiglas on both sides with only a four inch slot on one side of the instrument to provide limited and controlled access by the kids. The slot was just wide enough to put your hands in but too small for children to fit their heads through, thus making it impossible for anyone to receive exposure from the beam directly into their eyes. At the wattage each beam delivered, even reflected light fell well within the class I (safe) range for our application.

Switches

The three synthesizer instruments – the Jingle-Lingle-Lily, the Tone Stones and the Laser Harp, each generated an analog voltage trigger in its own way. These triggers were then sent to a common voltage-to-MIDI converter which in turn was routed to a Proteus sound module. The switches used to initiate the analog trigger were respectively: piezo switches housed within the flowers of the Jingle-Lingle-Lily; 12" foot switches set underneath the acrylic stones of the Tone Stones; and photo detectors responding to the interruption of a beam of laser light which was directed at them in the Laserharp.

Audio Control System

Five of the six instruments, acoustic and synthesized, were fed into a 16 channel Alesis mixer where audio effects such as reverb and digital delay were added to enhance some of the timbres and relative volume balance was achieved. The Alesis provided for four separate outputs to speakers - Master (Left and Right) and SubMaster (Left and Right). These four outputs represented four separate speaker zones in the Music Atrium room, providing a single zone each for the Tone Stones, the Laser Harp, the Jingle-Lingle-Lily, and the Boing-D-Boing. The Booble's audio was sent to all four zones, while the Honkblatt remained unamplified for reasons to be explained shortly.

As stated earlier, three of the 6 instruments are acoustic and three synthesizer based. Of the three acoustic instruments, two, the Booble and the Boing-D-Boing, require sound reinforcement in the form of a mic and contact pickups, respectively. The remaining acoustic instrument, the Honkblatt, proved to be so loud that it was not fed into the audio mix. In fact it was so loud that we wound up fashioning a mute out of rolled carpet to muffle the overwhelming sound of its pitched foghorns.

The three synthesizer instruments – the Jingle-Lingle-Lily, the Tone Stones and the Laser Harp – were all fed into an analog-to-MIDI converter which converted their respective voltage triggers into MIDI note messages. These three separate signals, each assigned to a separate MIDI channel, were then sent to a single Proteus sound module where they triggered their respective synthesizer/sampler sounds. The audio output of the Proteus was then sent to separate audio channels on the Alesis mixer where they were then routed to there respective speaker zones.

COMPOSITION AND HARMONIC TEMPLATE

My original concept was to create a space where great care was given to how each instrument sounded in relation to the other – to orchestrate the room by strictly defining the pitches for each instrument and imposing a specific harmonic template on the ensemble so that regardless of how the instruments were played the resulting sound would still be somewhat harmonic and musical.

Unfortunately, time and budget forced me to make painful modifications to this original plan. For example, the Booble whistles mentioned above came in three pitches which by default became the source material and tonal reference for the other instruments, that is until I finally located the foghorns. The foghorn pitches didn't bear the slightest tonal relation to the samba whistles which forced me to abandon any hope of having a diatonic ensemble. For my next Booble I'll want to produce custom whistles and foghorns at predeter-

mined pitches. (Any Nambu whistles makers out there? Give me a call at 914-736-3600.)

Obviously the pitches for the synthesizer instruments were totally selectable. I went with a whole-tone scale on the Laser Harp with the maximum number of pitches common to the Booble whistles, and I chose a chromatic vocal choir sound on the Tone Stones. The harp scale proved satisfying to the strumming action of most visitors and the step-wise chromatic vocal choir of the Tone Stones added an eerie, yet appealing, Gregorian chant-like quality to the room.

OPENING DAY

In spite of the necessary compromises needed to complete the project in time for the museum's royal opening in July of '92, the six instruments that comprised the Music Atrium were a huge success. The instruments performed as intended; children, without prompting or explanation, walked right up to the Booble, the Honkblatt, the Laser Harp and the others in the ensemble and with delighted looks on their faces played these fantastic and unusual instruments non-stop until their parents had to finally drag them away. Even HRH Prince Charles, who struck a royal strum on the Laser Harp, expressed his admiration at the creative display.

And although I would have preferred to be able to exercise more precise control of the harmonic elements of the instruments, the specific combination of sounds generated by this unusual collection of custom sound generating devices, while bordering on the cacophonous at times, still has its own, very identifiable unique characteristic harmonic texture, which evokes an undeniable sense of pure fun and play. And that was the point, after all.

Dean Friedman is a multimedia artist based in Peekskill, NY delving into virtual reality and new music and suffering from a severe case of that increasingly common malady, multi-media mania. His company Dean Friedman Productions Inc. creates virtual reality In Video environmnets for TV and museums around the world. His current projects include a children's album and a virtual reality In Video piece of the North Carolina Museum of Life and Science. For more information write: Dean Friedman Productions, Inc., P.O. Box 1286, Peekskill, NY 10566.

THE SOUNDSCAPE NEWSLETTER

World Soundscape Project, Department of Communication,
Simon Frasier University, Burnaby, B.C., Canada V5A 1S6

Review by Tom Nunn

The Soundscape Newsletter is a natural outgrowth of the efforts and experience of the World Soundscape Project (WSP), founded by R. Murray Schafer in the late 60s to study the acoustic environment and the impact of technology on it. Hildegard Westerkamp edits this relatively new publication in an effort to bring together various thoughts and perceptions about the present day sonic environment from "listeners" in many different fields. In the mid 70s, the WSP published, through ARC Publications, a series of small books, *The Vancouver Soundscape, Five Village Soundscapes, European Sound Diary* and the *Handbook for Acoustic Ecology*. I learned about these gems when they were first published and ordered three of them. I found the *Handbook* particularly interesting and useful as a source book for cross-referencing acoustics terminology in different fields of study. The WSP has accumulated 300 audio tapes of sound environments throughout B.C., Canada and Europe and has produced many written documents on the subject of the acoustic environment. Through this work, the WSP has stimulated a global interest in, and concern about, the nature and quality of sound in our personal lives, wherever we might live, contributing another aspect to our growing ecological awareness.

The *Newsletter* published its first issue in August 1991, inviting submissions in the form of articles, announcements, information on other related organizations and short personal bios. Also included was an update on the WSP and its future role, plus announcements of two major conferences, "Urban Sound Ecology" (June 1992) and "The Tuning of the World" (August 1993).

The second issue, published in January 1992, was a good illustration of the intense and diverse interest there already is in acoustic ecology, sound design and sonic art. Justin Winkler of Basel, Switzerland reported on the "Munich Klang-Design Symposium" that took place in December 1991, and the interdisciplinary colloquium "Klang Umwelt Design" (Sound Environment Design) in Kassel, Germany in November 1991. Gayle Young wrote about the Newfoundland Sound Symposium in 1990, and Johannes Wallmann described the Klangzeit symposium sponsored by "Bauhutte Klangzeit Wuppertal" (Bauhutte Soundtime) in 1991.

Other subjects included a music theater work by Susan Frykberg of Vancouver, "Woman And House," Daniel Janke's Yukon Project of "collecting sounds in the North," and several letters and brief personal bios from parties in Seattle, Tel-Aviv, Koln, Hiroshima, Victoria BC and Montreal. The International Society for Music and Medicine (ISMM0, the Environmental and Architectural Phenomenology Network and a radio show, "Pulse of the Planet" are also briefly described.

So, already in the second issue there is a wealth of information for this small 8-page newsletter. Again the World Soundscape Project comes up with a winner!

A third issue was published in June 1992, and the fourth is on its way. [The fourth issue has appeared since this was written -- ed.] If you have an interest in experimental musical instruments -- and obviously you do -- it's impossible for you not to find useful information in this newsletter, whether it be ideas, conferences, venues, installations, fellow students of sound in other parts of the world, tapes and CDs, books, or whatever. I can only imagine that this terrific newsletter will keep on going, and going, and going... The interest is there without a doubt. And the importance of the WSP mission cannot be underestimated, as it contributes to our new awareness of our relationship with the environment.

The modest subscription fee of $10 per year (or sFr 15) makes *The Soundscape Newsletter* a good..., or should I say *sound* investment.

RECORDINGS REVIEWS

By Mike Hovancsek, Tom Nunn & René van Peer

GREGORY ACKER: **DIFFERENT TONGUES**

On Cassette from Gregory Acker 518 Kentucky St. Louisville, KY 40203.

Plucked linguaphones (e.g. thumb pianos, mbiras, kalimbas, sansas, thumb drums, etc...) are among the easiest instruments to play. They are also some of the most enchanting. Their sound, falls somewhere between a plucked string, a voice, and a drum. [terminology note: some scholars suggest the term "lamellaphone" as preferable to "linguaphone"; but in light of the Acker's cassette title, "linguaphone" has a certain poetic appropriateness. -- ed.]

In "Different Tongues" Gregory Acker utilizes several different linguaphones of various designs and tunings to create a bed for his improvisations on assorted wind instruments. Among the accompanying instruments are Bolivian flute, soprano saxophone, Kabye flute, wooden penny whistle, recorder, ocarinas, angklungs, mouth bow, gangokui, Tibetan bells, rain stick, talking drum, and slide whistle.

Falling uncomfortably under the "New Age" banner, this tape tends to focus on the pretty, bright, and meditative potential in the featured instruments. Gregory Acker, however, is more than a mere fluff peddler. His multicultural tone combinations and his improvisational abilities reflect a sincerity and imagination that is often lacking in New Age releases.

"Different Tongues" isn't the most adventurous linguaphone recording ever made. Where it could easily wander into more experimental territory (e.g. self-designed electroacoustic linguaphones, bowed linguaphones, hammered linguaphones...) it never does. Consequently, people who are looking for an exploration into the many possibilities of this sort of instrument are likely to be frustrated with "Different Tongues".

People who are looking for a meditative, multicultural romp through the appealing sounds of linguaphones, however, will find this tape to be very enjoyable.

—MH

JOHN CIECIEL: **SPORT SINK COMPILATION**

(On Cassette from John Cieciel, 5879 S. Brainard Countryside IL 60525)

"Sport Sink Compilation" is not a formally packaged release (it doesn't have a cover or liner notes) and it was recorded without the benefit of multi-tracking or additional musicians; this recording is more like a sketchbook for interesting ideas. John plays mountain dulcimer, bowed psaltry, and a struck metal incense burner all of which have been heavily processed with electronic equipment. None of the improvisations on this tape sound like the folk music that generally emanates from dulcimers and psaltries. Instead, John uses these instruments to produce atonal, chaotic rushes of sound that develop more in terms of timbre than in terms of melodic content.

Some pieces seem to end abruptly before they develop into anything worthwhile. Other pieces tumble and soar through a wonderful range of interesting sounds. The pieces would benefit from overdubbing and/or the input from equalization because the pieces tend to sound a little scratchy.

John's refusal to use multi-tracking on "Sport Sink Compilation" indicates that he can reproduce these sounds in a live performance format. It would be interesting to hear John Cieciel perform live with an ensemble of like-minded musicians.

—MH

CONSPIRACY: **INTRAVENOUS**

On CD from Matchless Recordings, 2 Shetlocks Cottages, Matching Tye near Harlow, Essex CM17 0QR, United Kingdom (tel. 0279 731517)

A four-piece band of strings, keyboards and winds. Improvised stuff. At times raucous, at times delicate. Long passages in which interaction weaves a veil of suspense. All very well, but you may wonder how they drifted into these pages. This is because of Adam Bohman, playing "prepared strings" – adapted instruments on which all types of objects are placed, setups he amplifies with contact mikes. What makes *Intravenous* special is the matter-of-fact treatment Bohman's instruments get in the musical concept of the band. It appears to prevent their style from being emphatically jazzy. The music has a feel of looseness about it that puts it in between categories, nowhere quite fitting in. Which is as much as saying that it may keep you attentive, trying to fathom it.

—RvP

DAVID FIRST: **RESOLVER**

(On CD from O.O. Discs, 502 Anton St., Bridgeport, CT 06606-2121)

The experimental musical instrument featured in "Resolver"is manufactured by Casio. The experimental element of this recording is a programming technique David came up with that enables him to create sounds the Casio technicians had no idea their instrument could produce. Using an entry-level Casio CZ-1000 (he used four of them for the quartet pieces), David draws microtonal tunings that enable him to take keyboard electronics into new realms of sound.

How does he do it? To quote an article in **Keyboard**, "The tunings are programmed using the 1-2 line select option, with line 1's DCA envelope set so that segment 1 is the end segment. The detune parameters can then be used to fine-tune line 2 up or down". By storing 20 or 30 sounds into his synthesizer's memory (each sound being identical except for the tuning) David is able to change the tuning from one note to another.

The unusual tonal qualities of these timbres do odd things to the sounds: washes of harmonics drape themselves around the core pitches adding a nebulous, ghost-like quality. The pieces on "Resolver" that focus on the retuned synthesizers are long, static drones that are unvarying except for the most subtle elements. Many people will find these pieces to be too stark and undeveloped to hold their attention. Had David chosen to focus more on structure and rhythm, however, he would have driven the attention away from the subtle harmonic qualities.

In addition to the Casio pieces, a nebulous, shifting piece for guitars and an ominous midi-grand piano piece add some much needed variety to this recording.

People who are interested in microtonality may find "Resolver" to be an interesting study in sound. Others are likely to find this recording to be a test of their patience.

—MH

JOHN HAJESKI AND BARRY CHABALA: **THE CRYSTAL CHALET**

On cassette from 11 Rose St. East Rutherford, NJ 07073.

John Hajeski's self-designed Portable Anarchy instruments (radios that have been modified to produce electronic tones) were featured in Volume 7 #4 of this publication. In "Crystal Chalet" John collaborates with Barry Chabala to produce one of the most contemplative releases ever to emerge from the disemboweled remains of a radio.

Barry Chabala plays waterphones, bowed sheet metal, bowed steel, and flutes on top of John Hajeski's synthesizer, Portable Anarchy, bowed guitar, and bowed banjo. The result is a series of haunting, nebulous, gritty waves of sound that wash over and crash into each other like an ocean set into motion by a thunder storm.

While the Hajeski/Chabala collaboration consumes the entire first side of this 100 minute tape, side two is a series of pieces by John Hajeski that, in contrast to side one, tend to be abrasive and chaotic in nature. This side of "Crystal Chalet" includes the debut of the PA keyboard which John designed and built recently as an extension to his Portable Anarchy experiments. It also includes a piece in which John used a sequencer and a constant-change program to manipulate two synthesizers.

"The Crystal Chalet" is an interesting document to the music explored by two innovators. I highly recommend it to anyone who enjoys an earful of grit mixed in with their daily listening.

—MH

JUST INTONATION NETWORK, COMPILATION VOLUME II: **NUMBERS RACKET**

On cassette from Just Intonation Network, 535 Stevenson Street, San Francisco, CA 94103

The Just Intonation Network and its journal **1/1** should be a well-known phenomenon of those who regularly read our magazine. Like EMI they don't focus on styles, but on basics of music. Although the interests of both -- investigations into tunings and instruments -- are not identical, the sources do lie very close. This second compilation of music within the scope of the Network demonstrates differences in approach. Obviously mathematics play an important role in it. This has led several composers to realize their work on computers. Larry Polansky's piece, a cantillation from the Torah with interactive computer wandering towards compatible accompaniment, gives the listener the comfort that an account of Jewish history in Europe might do; to me it sounds like a metaphor for Jewry's search for a promised land where they can live in harmony. As such, the piece seems to reflect a dream rather than a realization. It was taken from Polansky's CD *The Theory of Impossible Melody*, issued by Artifact Records. Run by Tim Perkis (from The Hub and Tom Nunn's Rotodoti), this is a label for computer music with an adventurous and open-minded view. Worth your attention and support.

I hope you bear me getting carried away a bit just now. Apart from lighter stuff "Numbers Racket" also contains an excerpt of La Monte Young's five-hour composition *The Well-Tuned Piano*, which may give the tape weight in New Music circles. All in all a comprehensive catalogue of the heights, depths and width of Western music using non-tempered tuning systems.

—RvP

FRANCISCO LÓPEZ: **CRUSTOCEANIUM**

On cassette from Linea Alternativa, Apartado 49, 28800 Alcaláde Henares, Madrid, España

Having been brought up in the Catholic faith, I am well acquainted with the mystique of resonant metallophones. One stroke may conjure up a world of sound, which the listener can enter and stroll around in. Francisco López from Spain (a country renowned for its adherence to Catholicism) has done investigation into exactly this type of instrument. Apparently in the process of composing this tape some editing work has been done on the recordings of his instruments. It gives the music a distinct and striking electronic quality. Through association with the hard integument of crustaceans, he links this work with the sea. The music on this cassette should be heard mixed with the sound of waves, he says. As far as I am concerned the pieces do not really need this. Especially not those on side two: López recorded his instruments in what sounds like an immense, reverberating space. Hearing it on the spot must be a truly (awe-)inspiring experience of boundless sonic depth.

—RvP

HARRY PARTCH: **THE MUSIC OF HARRY PARTCH AND THE BEWITCHED**

CRI CD 7000 & 7001

Composers Recordings, Inc.: 73 Spring Street. New York, NY 10012

HARRY PARTCH: **REVELATION IN THE COURTHOUSE PARK**

CD/Tomato 2696552

I am aware that none of the material I want to describe in this piece is new. The compositions aren't, most of the recordings aren't -- and neither are the issues. However, when writing reviews for EMI, how can one not pay attention to CDs with music by Harry Partch, the man who developed a totally rational tuning-system, designed and built instruments for it, devised notation and composed for them? CRI re-released "The Bewitched", "...Petals Fell on Petaluma" and most of "From the Music of Harry Partch" on two issues. Tomato produced a double CD with "Revelation in the Courthouse Park".

First let me grumble a bit about CRI's albums. I don't quite see the point of including the final part from "The Bewitched" on "From the Music of...", when this stage-work is presented integrally on a separate issue -- especially as they left out one other composition. The tapes suffered considerably from time and storage. Most of the detailed notes and all the marvelous pictures that made the old records such precious items have been discarded. Even though these releases are of major importance, to the novice they would disclose but part of the joy, beauty and significance of Partch's achievements. Tomato's CD -- the recording of an extremely rare staging of Partch's work in 1987 -- has none of these drawbacks.

On a deeper level the attentive listener may find some striking discrepancies between the old and new recordings,

i.e. with and without the supervision of the composer. One of his main concerns was "corporeality": the physical aspect and impact of music. Freda Schell's performance in "The Bewitched" lends the piece a profoundly earthy and (well, yes) erotic quality, way before the sexual revolution and feminist emphasis on the witchy sensuality of womanhood. It makes this piece sound confronting every time I hear it. "Revelation" deals with sexual elements of rituals, was recorded after the last shreds of the secretive, Victorian approach to sexuality were torn away -- and yet the bacchanals in the piece take on the giggly atmosphere of scenes from boarding-school; there's nothing protagonist Suzanne Costallos (quite seductive at times) can do about it.

On the other hand, never to my knowledge have the sound, timbre and texture of his instruments been so immaculately recorded as on Tomato's CD. I would call one aspect particularly successful. Among the reasons for his endeavor to create a microtonal tuning system Partch mentioned that twelve-tone tempered tuning is too crude to adequately follow and accompany the spoken voice. The recitations in "Revelation" show his achievement in this respect. Arpeggiated strings and the slow boom of low-pitched marimba pervade speech with a sense of regal doom. The combination is dramatic, but never transgresses into theatrical gestures. Still the total impact of the older recordings to my judgment comes closest to his intentions.

To sum up: any release with Partch's music should be of prime importance to readers of this magazine – this is where EMI's subject-matter came from. It is to be hoped that CBS and New World Records will re-issue their Partchiana on CD. His work is a monument of the spirit of the visionary rebel, the inventive individual (which I, as a European, have always thought to be at the mythical heart of American civilization) and it would be only appropriate if America treated it as such.

—RvP

HAL RAMMEL: **MUSIC FROM THE JAWS OF SOUND**

On cassette from Cloud Eight Audio, P.O. Box 1836 Evanston, IL. 60204-1836.

It is not often we hear a single experimental musical instrument on a cassette, but Hal Rammel's "Music From the Jaws of Sound" is a successful version of such a difficult venture. Hal's Sound Pallet is an extraordinary electroacoustic instrument, both in its range of sound and its utter simplicity of design.

Upon first hearing "Jaws," I thought I recognized a couple of the sounds Hal was using. Without reading the liner notes, I listened to most of the first side and would have sworn I heard plucked nails and bowed steel rods, sounds I'm very familiar with in my own work. However, I discovered the Sound Pallet is simply an artist's pallet (gloriously painted, of course) with *wooden* rods protruding from the board along the perimeter (no metal at all). The instrument utilizes contact microphone, processing and amplification to achieve a surprising range of sonic delights and a convincing stereophonic, polyphonic, multitimbral electronic music.

Aside from the sounds themselves, "Jaws" shows a musical sensitivity and creative insight into the potential of the instrument that truly allows an entire cassette to be devoted to it. We hear a shamelessly outright electronic music with effective channel shifting, primitive howls, and at times a strange kind of sonic environmental ambience. But throughout,there is a consistency of style and convincing musical gesture that takes us along with the music. And the recording quality is excellent.

Hal Rammel's work combining experimental musical instruments with electronic processing is something EMI readers should check out. Today contact microphones (pickups) and numerous different processors (analog and digital) are relatively inexpensive and very effective. "Music From the Jaws of Sound" is an excellent example of the rewards reaped from exploring the electroacoustic magic of a simple idea.

—TN

GINO ROBAIR: **OTHER DESTINATIONS**

On CD from Rastascan Records P.O. Box 3073 San Leandro, CA 94578-3073.

At last, an electronic music project that sounds human. Gino Robair recorded "Other Destinations" using an interactive computer program, a theremin, voice, analog synthesizers, and an assortment of home made percussion devices. Among the homemade instruments are "a number of gongs, gas canister bells, wobbleboards made from gas station numbers, hoses and whirlies, metallophones using copper slabs and pieces of mufflers".

The compositions in this recording are active, exciting interactions between the acoustic and electronic timbres. Gino's use of electronics is effective here because he wisely avoids the sterile, spacey sound that one may come to expect from electronic music. Even the theremin, which has been hopelessly ingrained into the kitschy science fiction films of the 1950s, sounds like a Vietnamese reed instrument in Gino's hands.

The structural elements of "Other Destinations" are particularly interesting. The rhythms and dynamics defy the conventions of jazz, rock, or classical music resulting in an uncategorizable interaction between interesting timbres. Leave it to a percussionist to develop such a complex interplay of rhythms and structures.

—MH

NEIL B. ROLNICK: **ELECTRICITY**

On CD from O.O. Discs 502 Anton St. Bridgeport, CT 06606-2121.

"ElectriCity" is a CD of Neil Rolnick's works most of which deal with the interaction between acoustic instruments and electronics. The title piece is a performance by the New York New Music Ensemble for flute, clarinet, violin, cello, synthesizer, sampler, and digital processing. Other works include a piece for extended playing techniques for flute and two pieces for solo instruments interacting with computer generated tape.

There are times in this recording when the electronic sounds alienate the acoustic sounds, the result being like a radio caught between two very different stations. At other times the electronic/acoustic relationship is really interesting. This is particularly true when percussive-sounding electronic timbres are used and when the digital processing is more prominent than the synthesizer.

Fortunately, the synthesizer, which is rarely used effectively in this recording, gets packed away after the first piece so that the more interesting elements of this project can present themselves. The solo percussion/computer generated tape piece, for example, is especially successful in creating a live interaction between human and machine.

Although it doesn't fit into the electronic/acoustic theme of "ElectriCity", the solo flute piece offers a nice bit of variety to the recording. It also proves to be an effective vehicle for extended playing techniques and strongly hints at the composer's understanding of the instrument.

Overall, "ElectriCity" is a fine, if uneven, exploration into the interaction between electronic and acoustic sounds.

As is, this group seems to be a long running joke that only they understand. They sure would be a lot of fun to play with, though.

—MH

VARIOUS ARTISTS: **POSTAL SOUND SURGERY**

On cassette from Pointless Music, 1889 Algonquin, Kent, OH 44240, USA.

The multitude of musical styles and characterizations expressed in "Postal Sound Surgery" is astonishing and delightful. While maintaining an overall stylistic ambience of experimental music, the different personalities in this cassette come through shining. And what a practical form of collaboration!

Each piece is a separate collaboration between Mike Hovancsek of Pointless Music, the ever-growing label of this cassette, and other superb and adventurous musicians (listed below). The collaboration amounts to one musician mailing another musician a four-track cassette tape, two tracks of which are a recording of the first person's contribution. The second adds his/her two tracks then one or the other masters the mix to achieve the final product. Sometimes Mike would lay down the first tracks, sometimes the second.

This kind of collaboration is definitely "postal." As for the "sound," it's in there in a big way. For example, consider the instrumentation: percussion, synth, sampler, Thai flute, kalimba, computer generated electronics modified guitar, drum kit, Zheng, chorus and lead er hu, temple bells, "Portable Anarchy", guitar, assorted wood and bamboo xylophones, balafon, gongs, bells, homemade percussion, clarinet, Ryom, the Columbia music computer (circa 1959), sound sculpture, tape manipulation, ball, vocals, extraneous noises, a radio show, drum machine, viola, turntable piano, bowed and struck metals...Whew! Although these are obviously not all experimental musical instruments, their bizarre applications on this cassette makes them at least sonic kissing cousins.

What is really amazing is that the music comes off so well, considering the collaborators are literally hundreds of miles away from one another. Their experience playing together is necessarily limited, yet the impression in all of these pieces is that of a fine rapport and a solid stylistic, free-music concept about what's going on.

So, if you're up to this much music (I sure was), go for it, and open your mind to another kind of "surgical" procedure, one that puts in instead of takes out!

Collaborative musicians appearing on the Postal Sound Surgery cassette: Roger Skulback, Ethan Lebovics, John Wiggins, Michael Gendreau, Q.R. Ghazala, John Hajeski, Bil King, Henry Kungz, Barry Chabala, Halim El Dabh, Charlie Goucher, Rick Bishop, Alan Bishop, Ahmad (of the Disgruntled Postal Employees), DAS (of Big City Orchestra), Chris Sidorfski, Jon F. Allen, Dimthingshine.

—TN

VARIOUS ARTISTS: **SOUND SYMPOSIUM 1990**

On cassette from Sound Symposium, 81 Circular Road, St. John's, NF, Canada A1C 2Z5

In his review of the festival from which this cassette was compiled, EAR's David Laskin said (in his now sadly discontinued publication, Vol 15 No 7), "Sound Symposium takes on the feeling of a family affair," concluding that its great indulgence "was not merely witnessing such events but engaging their creators and other interested parties in sincere discussion, in a real community of sound and experience in which role-playing of professional art gave way to something more personal, more humane, much needed." On the evidence of the tracks presented on this cassette I can only agree with him. The pieces shine with the elation, the high spirits of a thoroughly successful party. The selection proves the variety of styles in the festival, including this most splendid of all categories – miscellaneous. Judging from the tape, however, the symposium seems to have been more about music than about sound; so don't let the title send you astray. My favorite: Gordon Monahan's *This Piano Thing*, roaming in the wild no-man's-land between sound and music. Or, how to bend this most rigid of classical instruments. Yoga for broomsticks. Maybe he is not the first, hopefully he will not be the last.

—RvP

From the editor: Starting with this issue, we have two new recordings reviewers on board. René van Peer, of Tilburg, Holland, is a freelance journalist dealing with experimental art and music, and ethnic music. He writes on a regular basis about these topics for Dutch newspapers and magazines. North American publications **EAR** Magazine and **Musicworks** have printed articles and reviews he wrote. His interest pivots around exploration, function and content. He likes surprises, myths and tales from oral tradition, and Asian cooking. Tom Nunn, of San Francisco, has explored improvisation with experimental instruments since 1975. He has a bachelors and a masters degree in composition, and has written articles for EMI, **Leonardo**, **Musicworks** and **Percussive Notes**, and has been featured in San Francisco's **Image** magazine. He has a keen interest in the connection between experimental instruments and improvisation.

Recordings for review may be sent to EMI at PO Box 784, Nicasio, CA 94946, or directly to the reviewers: Rene van Peer, Bachlaan 786, 5011 BS, Tilburg, Holland, or Tom Nunn, 3016 25th St., San Francisco, CA 94110, USA.

Reviews by Mike Hovancsek, several of which appear above, will appear in the coming issue as well, and then no more. Since Mike started writing reviews for us some time ago, there has been an ongoing editorial debate behind the scenes around here: Should EMI run critical reviews – meaning reviews that make aesthetic judgments (whether pro or con) about the material under consideration? Or should EMI not be in the business of music criticism, but instead take a position of support for creative endeavor wherever we find it, and accordingly stick with reviews that are primarily informational in nature? Mike took the position that reviews which are barred from aesthetic judgment are bound to lack substance, and it was with that understanding that he agreed to take on the role of reviewer. But the editor has now come to the decision that the passing of aesthetic judgment does not sit well with the essential purposes that EMI serves for its readers. That is at odds with Mike's reviewing philosophy, and so he will no longer be writing reviews for us.

EMI owes a great debt to Mike Hovancsek. He took a moribund reviews section and brought it to life. In doing so he brought in a lot of new people and new music, and established the reviews section as a place where a wider range of topics could be brought to bear. Hopefully the reviews section will continue to fill that special role. Meanwhile, you will continue to see Mike's name in other connections in the pages of EMI.

Circuit-Bending and Living Instruments

The Photon Clarinet

by Qubais Reed Ghazala

Music: elusive, momentary ...lasting.
We are creatures of complex emotion and we breed a certain magic in our art. Each of us is an expansive set of interconnected feelings, we emotionally respond to even the most subtle changes in our environment and are thereby very vulnerable to the color, the sound, and the moment. When the artist reaches a blade inside the jar to touch a pigment, the artist is reaching the blade inside us to touch an emotion, a feeling. There is magic in this. Not the sleight of the parlor or the illusion of the stage ...but real magic, where from thin air the emotions are fostered rather than tricked into being.

Upon the parchment of our history music and magic intertwine like serpentine vines, more important at times than the searching creatures that they nourish with revelation or shelter from the truth, though mankind has found equal comfort in the cradles of each. The rituals of our species are laced together with these things ...we are creatures of magic, music, and emotion.

Circuit-Bending and Living Instruments, *by Q.R. Ghazala*

THE PHOTON CLARINET

(continued from previous page)

The unexpected and the unexplained rule the world of magic. Certain musical instruments add these qualities to the already magical impact that all instruments with expressive voice naturally carry. In these instruments the listener becomes captivated as though this merging excites memories of ancient mysteries that still beckon like a strange bird-song from the shadowy edges of a forgotten ancestral camp.

Sometimes it's the voice, while at other times it's the musician's technique that seems to challenge reality. In my personal experience within the major instrument groups several examples come to mind. With a few modifications, the Hungarian cimbalom is a larger version of the better known hammer dulcimer. Roughly the size of a piano, it stands on four massive legs, contains around 120 strings divided into two courses, has a pedal controlled damping system, and is commonly played with compressed feather mallets. The solid construction of the deep trapezoid sounding box creates resonances of a surprising nature when the instrument is plucked in the manner one would play a harp or koto. The cimbalom I found was in pieces, being evicted from a suburban garage to make way for the family car. Evening came on as I brought the great body of the instrument into the house to assemble and tune. The case was inlaid with mother-of-pearl and silver, the damping bars were polished mahogany, and the legs were thickly turned pedestals. I lit two candles that evening, one on either side of the shining black instrument, and sat down to explore.

The magical voice of this cimbalom appears in the decay of its sound envelope. If a series of strings are plucked and left undamped to resonate freely until silent, during the course of this event sympathetic groupings of other strings become strongly active adding the effect of choral accents swelling behind the root voice. Since it's the natural tendency of vibrating objects to set other objects of similar or harmonically tangent resonant frequency into motion also, this effect from the cimbalom could be expected were it not for the startling degree of presence and separate timings that these phantom notes achieved. It was almost as if the strings of separate miniature chamber orchestras were being bowed at different points within the instrument's body. The effect was very enchanting, sounding at times like a choir of angels calling from a vanishing dream.

In the percussion family, the Chinese tiger gong speaks with a surprising voice. The one I use is about 10" in diameter, though larger and smaller ones exist as well. Striking the instrument at the inner edge of its broad flat boss produces a dense ringing tone that immediately drops in pitch over a range of three or four notes, fading out holding the lowest frequencies achieved. The effect is really rather stunning.

Many wind instruments create strange or unexpected voicings, but the homemade racket, based upon a Renaissance design, places very unusual sonorities in the hands of anyone who has twenty minutes available to construct it. No one knows how many attempts have been made to condense a very long musical tube into a manageable system of bends and loops so that the player can with one hand cover pitch holes that are in reality separated by many inches (or feet) of air-column. The racket does just this. The original version was the shape of a stout cylinder about the size of a round oatmeal box. A long thin tube snaked up and down inside it, just behind the cylinder's walls. This tube was intersected by small open ports leading to the outside, arranged so that they could be covered by the player's fingers thereby producing the desired note as the reed in the upper end of the long tube was blown.

To build the homemade version, simply coil some rubber or PVC tubing, with about a one-quarter to one-half inch inner diameter, around a good sized empty can whose bottom has been removed. Let a few inches of this tube extend above the top of the can. Into this end you later insert a double-reed from an oboe. (The one I use is from a bagpipe chanter, but any single or double reed system of similar size will work.) Holes are then drilled or melted into the tubing in a straight row down the front of the coil, one for each loop of the winding. With the reed towards you and the holes away, the device is played like a saxophone. While all the holes are covered you'll be playing a tube around six to eight feet long. Yes, the voice of this instrument is rather thin, it's this, however, that makes the deep bass notes so interesting. Try it!

At times it's the playing technique rather than the voice that makes an instrument seem mysterious and magical. I'm somewhat familiar with the Chinese er hu, whose playing certainly demands the abandonment of dominant western design concepts. Not only is the bow's bolt of hair strung between the two strings (or on some models a double bow strung between four strings), pushed toward and away from you to play either one, but there is no fingerboard whatsoever (let alone frets) to guide the hand. The fingertips simply rest upon the strings to find their pitches, with pressure as well as placement shaping the notes. Watching a skilled er hu player is astonishing. The sharp presence of the voice combined with the musician's fingers dancing inches away from any solid matter of the neck or body is truly captivating.

Bowl gongs are now becoming common in Great Britain and the West. You've probably played one or have seen someone bring the haunting note out of such a gong by means of friction rather than direct percussion. While the wooden handle of the common striker is often used to bring up the rising volume of a bowl gong by circular stroking of the upturned rim, the soft suede is meant for this purpose, of course, and produces a much purer tone after a little practice. Anyone who has watched and heard this done with a good instrument, regardless of the gong's size, is amazed at the magical release of this singing metal, crystal, stone, or glass.

Certain wind instruments also have unexpected playing techniques, and in my own experience I might discuss the bagpipes (whose Medieval predecessor was an entire pigskin with the chanter stuck into the mouth), the humanatone (or nose flute, exhaled through by means of the nostrils while the mouth cavity controls pitch), twirling tubes, and a few others, but since we're talking about the relationship between magic and music, I can't resist mentioning the true nature of one of the Greek temple oracles. It's now known that many of the eternal fountains, talking statues, and other mysterious devices of the priests were actually simple mechanical deceit. But to the worshiper of the day, there was a small miracle in the chorusing of hidden trumpets sounding in unison with the opening of the temple's common door. We know now that a simple system of hydraulics under the flooring moved cylinders, at times quite a distance away, compressing air in one fashion or another to bring the veiled chorus to life. I suspect magic horns still cry out in many of our temples, miraculous in the same way.

Finally, there are instruments that combine both of these qualities, having magic in the voice and the playing technique at once... bringing us to the Photon Clarinet. Although cir-

cuit-bending* did refine the end product, this design is original and, unlike most circuit-bending, does not rely upon altering a pre-assembled circuit board.

I remember a day back in grade school when we were marched past the presidents in the green-tiled halls to an assembly at the auditorium with its mile-high ceiling. A suburban public elementary school in the 50's... our hair was combed, the teachers watched the flocks, and in the principal's office hung the paddle, a seldom seen yet often pondered God. Into this straight-and-narrow came that day a Theremin. I really didn't understand what I was seeing, so it was magic. Part of the school's agenda involved bringing an unusual music program to the stage. All sorts of instruments were demonstrated, many very mystifying to young school children. The musical saw, singing water glasses, thunder sheets... but to watch as the musician waved hands around a silvery metal loop stemming from the top of a mysterious box, and to hear in response what sounded like an operatic woman's voice singing from within hit me in a way that had me somewhat stunned for the rest of the week. The Photon Clarinet is controlled in much the same way.

While the playing technique of the Theremin is certainly unusual, its main voice is simply that of an oscillator caused to smoothly glide across its range due to radio interference imposed by the musician's body. Using light rather than RF, one of the two sensors of my modern Photon Clarinet does the same, while the other sensor is responsible for the more unexpected music that the instrument creates. When a hand is waved over this second sensor, the pitch steps rather than drifts between notes, as if the player is riffing upon a fretted or keyed instrument. Each sensor will allow the pitch to travel its entire range, from very high to so low that only clicking pulses are audible. In use, the player generally modulates the light falling upon the 'sweep' sensor with the left hand, and the 'step' sensor with the right. What this does, in effect, is to rather strangely replicate the process of playing a keyboard... left hand on the pitch-bend wheel and right hand on the keys.

Both sensors contain a standard cadmium-sulfide photo-cell, (photo-resistor). Actually, just about any electronic audio oscillator contains a resistor that can be replaced by a photo-cell to create a photon-sensitive instrument... in many

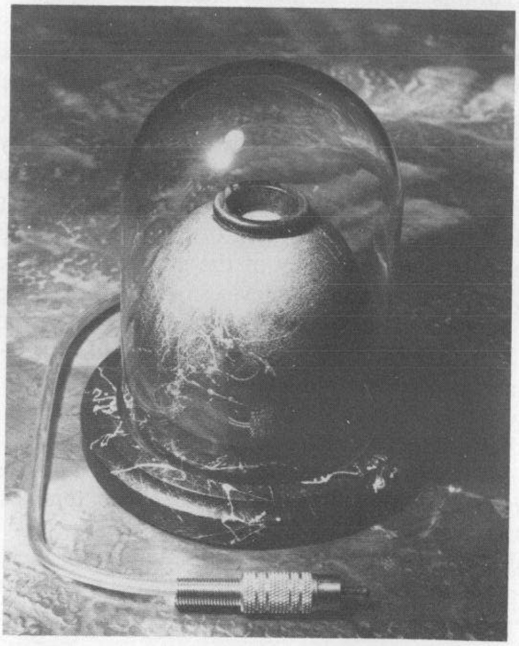
*Ciruit-Bending refers to the process of creative short-circuiting by which standard audio electronics are radically modified to produce unique experimental instruments. A further description of these techniques can be read in EMI Volume VIII #1, Sept. 1992

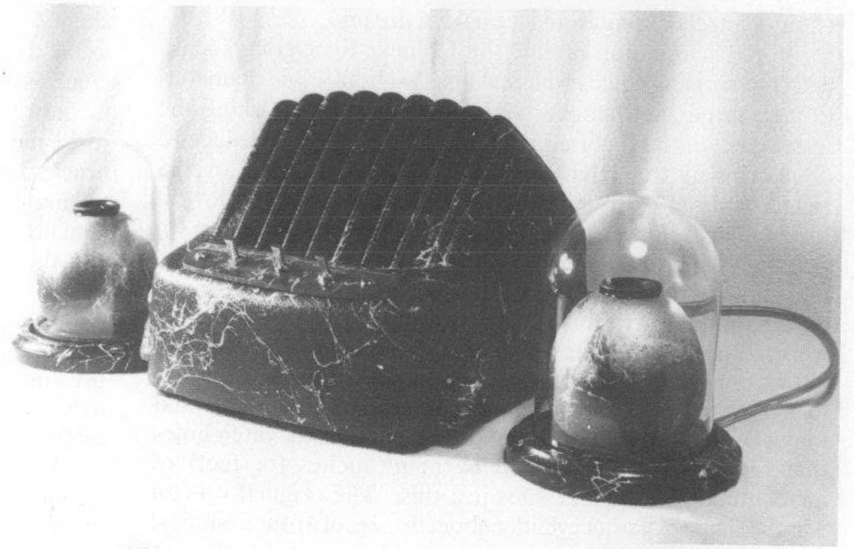
Above left: Intermediate Photon Clarinet, commissioned by Marc Sloan.

Below left: Photon sensor with glass dust cover.

Above right: Modern Photon Clarinet, built for Tom Waits' use in a German production of **Alice in Wonderland**.

Below right: Custom Photon Clarinet built into an antique intercom housing.





cases this will simply be the pitch control on the front panel of the unit. The basic modification would be to mount an input for the sensor on the panel in addition to a switch that could select between both control sources (the new cell and the old rotary control). Half of the Photon Clarinet circuit is devoted to this function, with the other half designed as a "frequency divider." Most audio experimenter's books detail simple frequency dividers, and they're not very difficult to build.

My original Photon Clarinet was simply that, a frequency-divider controlled by a photo-cell. The small box contained the battery, circuit, and speaker, with the cell and the power switch mounted to the outside of the case. As shadows of the hand fall upon the cell, the capacitor-filtered clarinet- like tone steps up and down its unconventional scale. This version is about as basic as you can get with the concept. No line output, one voice, one function.

The second Photon Clarinet was a much more serious project. This one was for musical performance and was commissioned by Marc Sloan, director of the NYC Gawk Ensemble and bassist for Ritual Tension and Elliott Sharp's Carbon. Though it abandoned the speaker, it was the first Photon Clarinet to use two sensors and the first to include a line-output for processing and amplification.

Since then, a few more steps have been taken to further the design. Today's Photon Clarinet contains, along with a line-output and the two sensors mounted in sculptural bases, LEDs for both power and envelope, a volume control, a focus switch which compresses and filter- sweeps the signal (creating a second voice), an initialize control which steps through a series of pitches and establishes the free note that the unmodulated instrument will return to, plus an internal monitor speaker with cut-out switch.

Many different effects can be achieved by playing the instrument as described before. In addition to simply riffing with the right hand and modulating with left, careful movements over the step cell will cause filter and loudness shifts over the shadow-span of a single note, before the light threshold necessary to change to the next note is reached. This allows the right hand over the step cell to induce tremolo (volume fluctuation) as the left hand over the sweep cell controls vibrato (pitch fluctuation). While the stepped notes of the Photon Clarinet scales don't follow intervals we are familiar with, a practiced musician can bend the pitches thereby persuading enough conformity from the device to allow accompaniment of traditional musics. Personally, I see no more reason to demand this of an instrument than I would a songbird. The abstract calls of nature, blind to the logic of musical semantics, are emotionally powerful, descriptive sound-forms, and I feel that even instruments entirely restricted to such voicings stand upon equal ground with the rest.

Although the Photon Clarinet was designed and built from scratch, circuit-bending still played an important role in its development. Both the compressed voice and the envelope LED were found in this manner as I probed and shorted the circuit's pathways with various diodes, resistors, and capacitors. In addition to CdS photo-cells, audio generators can be made light-sensitive using many other photo-active components including photo-diodes, photothyristors, phototransistors, LASCRS (light-activated silicon-controlled rectifiers), and solar cells. One of the great things about prototyping electronics is that small explorations can lead to great discoveries.

The idea of an instrument played with shadows is somehow poignant to me, as I live in a time where art itself on occasion seems to be slipping into the shadows. Perhaps planet- bound material art can whisper of its own destiny while its roots are still nourished in the here-and-now, while its fruit still ripens on the vine. Art quietly beckons to me in these ways, and some day my spirit may long to again feel gravity pressing me into the leaves... so I savor the fruits of my world.

ACKNOWLEDGMENTS

Computer assistance by Tony Graff, painter and fine artist.

The author will accept commissions to construct any of his devices covered in EMI, circuit-bent or original, although availability of specific electronics for bending is often uncertain. Contact Q. R. Ghazala at Sound Theater, ECHO 241, 7672 Montgomery Rd., Cincinnati, Ohio 45236.

RECENT ARTICLES, continued from back cover

CAS Journal Vol 2 #2 (Series II), November 1992 (112 Essex Ave., Montclair, NJ 07042), contains several studies on violin top plate and body design, as well as a computer-simulation study of the bowing attack in violins, and a proposal for a curved fingerboard for the violin family which would make the action more consistent over the neck (reducing the need for it to be higher in the upper reaches).

"Where'd That Guitar Come From, Anyway?" (no author credited), in **The Music Trades** Oct 1992 (80 West St., PO Box 432, Englewood, NJ 07631).

A report on the internationalization of guitar manufacturing. Japan no longer leads the industry in volume; that honor is now held by Korea; yet things look bright for the future in Indonesia. Funny, when you consider that until 30 years ago, guitar-making was almost entirely a small-scale, localized business.

"How Leblanc's Computers Advance Instrument Making" (no author credited), in **The Music Trades** Nov 1992 (address above).

Computer-aided design, computer-controlled robotics and computer quality-control systems in wind instrument manufacture at Leblanc Co.

"Advancing the Art of Piano Building" (no author credited), in **The Music Trades** Dec 1992 (address above).

As with woodwinds in the preceding article, computer-aided design and manufacturing techniques are having substantial impact on piano making, although basic piano design remains static.

American Lutherie #31, Fall 1991 (8222 South Park Ave., Tacoma, WA 98408) contains these articles, among others:

"Commercial Graphite Acoustic Guitars", by John A. Decker, Jr., discusses the use of fiber-reinforced resins, particularly graphite/epoxy, in the manufacture of guitar bodies and soundboards.

"An Ingenious Epinette", by John Bromka, describes a very pretty fretted zither (similar to Appalachian dulcimer) made by Gilles Pequinot, with a clever capo-like arrangement.

"D'Aquisto Opens New String Factory", by Tim Olsen, reports on the recent opening of a new musical string manufacturing plant — a significant event given that the plethora of available strings brands all actually come from one or another of a very few manufacturing plants.

The Autoharpoholic, which has been the primary periodical devoted to autoharps, has published its last with the current Winter 1993 issue. Thanks to editor/publisher Becky Blackley and the magazine's many contributors for thirteen informative and personable years of autoharp news and lore.

The following is a listing of selected articles relating to musical instruments which have appeared recently in other publications. If you come across articles that are appropriate for inclusion here, please send a copy along with the periodical's name, address and date to EMI at Box 784, Nicasio, CA 94946. To those who have sent articles for inclusion in this issue's listing, thanks.

"Jacques de Vaucanson's Mechanical Flute Player" by Penelope Mathiesen, in her regular "Winds of Yore" column in **Continuo** Vol 16 #6, December 1992 (PO Box 327, Hammondsport, NY 14840).

A description of a flute-playing automaton (early automated mechanical figure) made by Jacques de Vaucanson in Paris sometime around 1738. The article also discusses a treatise that Vaucanson produced on this and other mechanical figures, which presents research into flute acoustics he did in connection with the making of the automaton.

"Clavichord Tuning" by Richard Troeger, in **Continuo** Volume 16 #5, August to Oct 1992 (address above).

Practical notes on tuning procedures for clavichords, many of which might be useful for other multiple-course zither-like instruments as well.

"Quincentenary Strings" by Paul R. Laird, in his regular "That Gut Feeling" column in **Continuo** Volume 16 #5, August to Oct 1992 (address above).

Descriptions, with some photographs, of string instruments in use in the Iberian Peninsula around 1492 (with a brief bow to American instruments of the same period).

"Professional Musical Saws" by Luther G. Harris, in **Musical Saw News** Issue #16, November 1992 (PO Box 84935, San Diego, CA 92135-4935).

This short article discusses made-for-music saws made by Mussehl and Westphal. Planned for **Musical Saw News**' next issue is a report on musical saws manufactured by Charlie Blacklock.

"Recording Telluric Signals, Part I" by Gerry Vassilatos, in **The Journal of Borderland Research** Volume XLVIII, #6, Nov-Dec 1992 (PO Box 429, Garberville, CA 95542-0429).

A report on the monitoring and recording of electrical signals that can be picked up from the ground using specially-designed electromagnetic pickups for conversion to audio.

"Embaire Xylophone Music of Samurisi Babalanda (Uganda 1968)" by Gerhard Kubik, in **The World of Music** 1/1992 (Florian Noetzel Edition, PO Box 580, D-2940 Wilhelmshaven, Germany).

A report on xylophone music in the Busoga region of Uganda, focussing primarily on musical structure and playing technique.

"Club Dates: Hal Rammel's Sound Constructions" by Renaldo Migaldi, in **The Reader** Vol. 22 #5, Oct 30 1992 (Chicago, IL).

A one-page article, with photographs, on Hal Rammel and some of his instruments, including a slide membrane reed horn, sound palette, and devil's fiddle.

"Bad Vibes?" by Jeff Vovakes, in **TechniCom" Vol 16 #6, Nov-Dec 1992 (PO Box 51, Normal, IL 61761).**

Procedures for vibraphone restoration and repair.

"Repadding the Saxophone Step By Step: One Technician's Procedure" by Richard Sherman, also in **TechniCom" Vol 16 #6, Nov-Dec 1992 (address above).**

Saxophone repadding procedures, in a practical and straightforward presentation.

"A Xen Kind of Experience" by Simone Butler, in the "On the Town" section in **On Air**, Dec 1992 (magazine of the PBS stations in San Diego).

Notes from an interview with Ivor Darreg, microtonal theorist/anti-theorist and instrument maker.

"Max Mathews: Towards Expressive Performance in Computer Music" by Ted Rust, in **Music for the Love of It" Vol 5 #6, Dec 1992 (67 Parkside Dr., Berkeley, CA 94705).**

An interview with Max Mathews, whose computer program *Conductor* allows for real-time control of expressive qualities in computer playback of existing scores.

"Clyde Tyndale and Euterpe Harps" by Becky Blackley, in **The Autoharpoholic** Vol 13 #4, Fall 1992 (PO Box 504, Brisbane, CA 94005), and "The Basement Builders: Ron Wall", also by Becky Blackley, in **The Autoharopoholic** Vol. 14 #1.

Two interviews with autoharp makers.

Koukin Journal #4, June 1992 (1-12-24, Midorigaoka, Ageo, Saitama 362, Japan) contains articles (in Japanese) on Koukin (Jew's harps) of China's Yunnan Province, Iran, and Indonesia, plus retrospectives on the 2nd International Trump Congress that took place in Siberia last year.

"Report from Hawaii" by John Koster, in **Newsletter of the American Musical Instrument Society** Vol XXI #3, Oct 1992 (414 E. Clark St., Vermillion SD 57069-2390).

The author visited Honolulu's Bishop Museum, which contains a lot of older Hawaiian cultural artifacts including instruments, as well as (at the time of the author's visit) current musical exhibits including a sound sculpture by Steven Rosenthal, a photograph of which appears with the article.

"Violute Search Underway" (no author credited), also in AMIS Newsletter (address above).

The great grandson of George Hambrecht, inventor of an experimental violin called the violute, is seeking surviving specimens. Contact James Dillon at 98A Rockland St, Swampscott, MA 01907.

FoMRHI Quarterly #69, Oct 1992 (c/o Faculty of Music, St. Aldate's, Oxford 0X1 1DB, U.K.) contains the usual wealth of data on historical instruments and their construction & preservation, including:

"How to Design a Traverso", by Manfred Brach, containing scaling data for one-key flutes;

"A Stringing/Tuning Guide for the Irish Harp", by John Downing; and

"How my Harpsichord Goes Out of Tune", by R.K. Lee, discussing patterns of pitch slippage over time in harpsichord strings subjected to humidity changes, etc.

(Continued on page 39)